Dr. Dobb's Journal

SOFTWARE TOOLS FOR ADVANCED PROGRAMMERS

#104 JUNE 1985 $2.95 (3.95 CANADA)

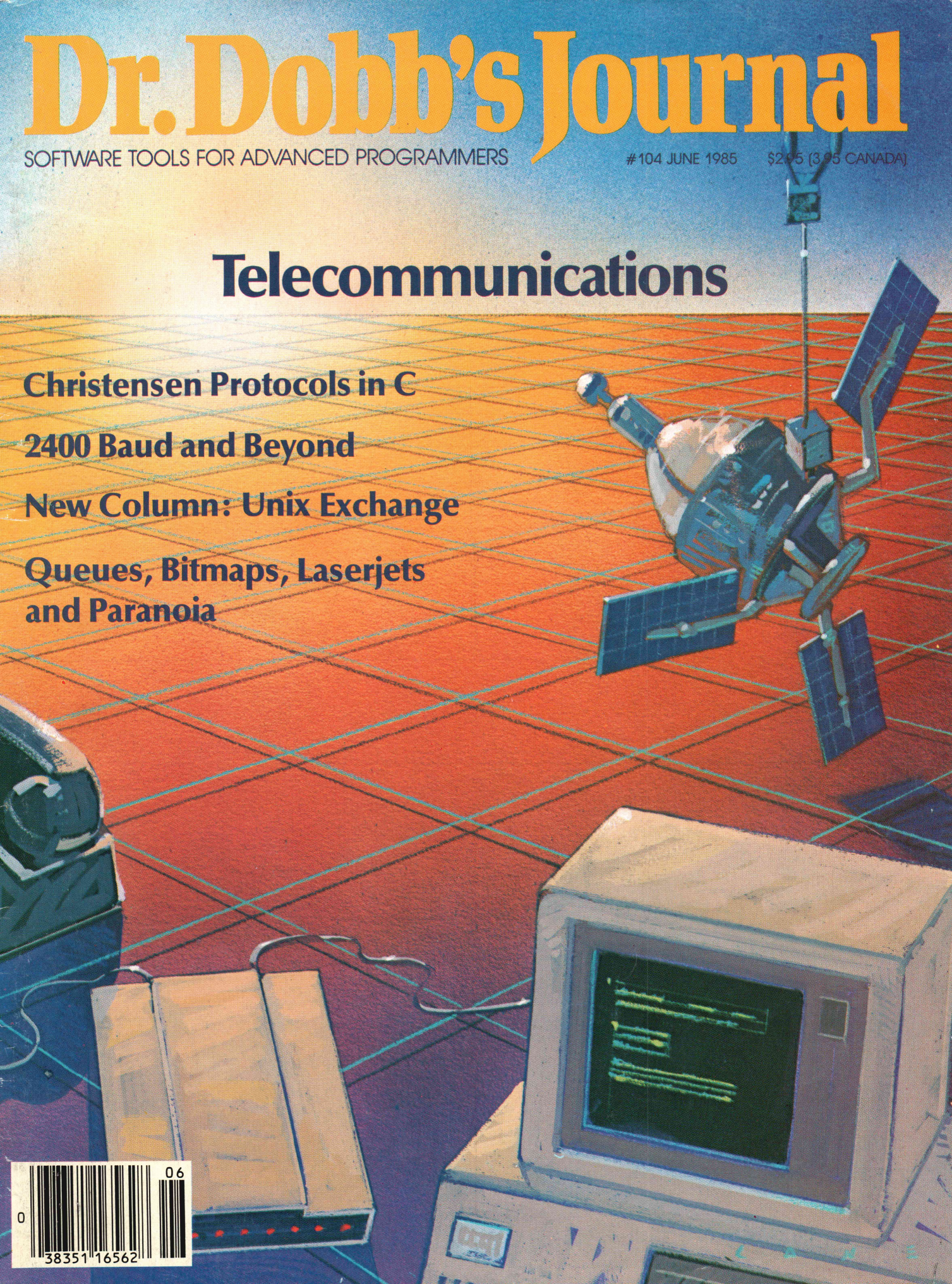
Telecommunications

Christensen Protocols in C

2400 Baud and Beyond

New Column: Unix Exchange

Queues, Bitmaps, Laserjets and Paranoia



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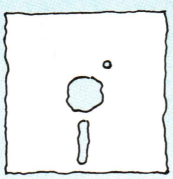

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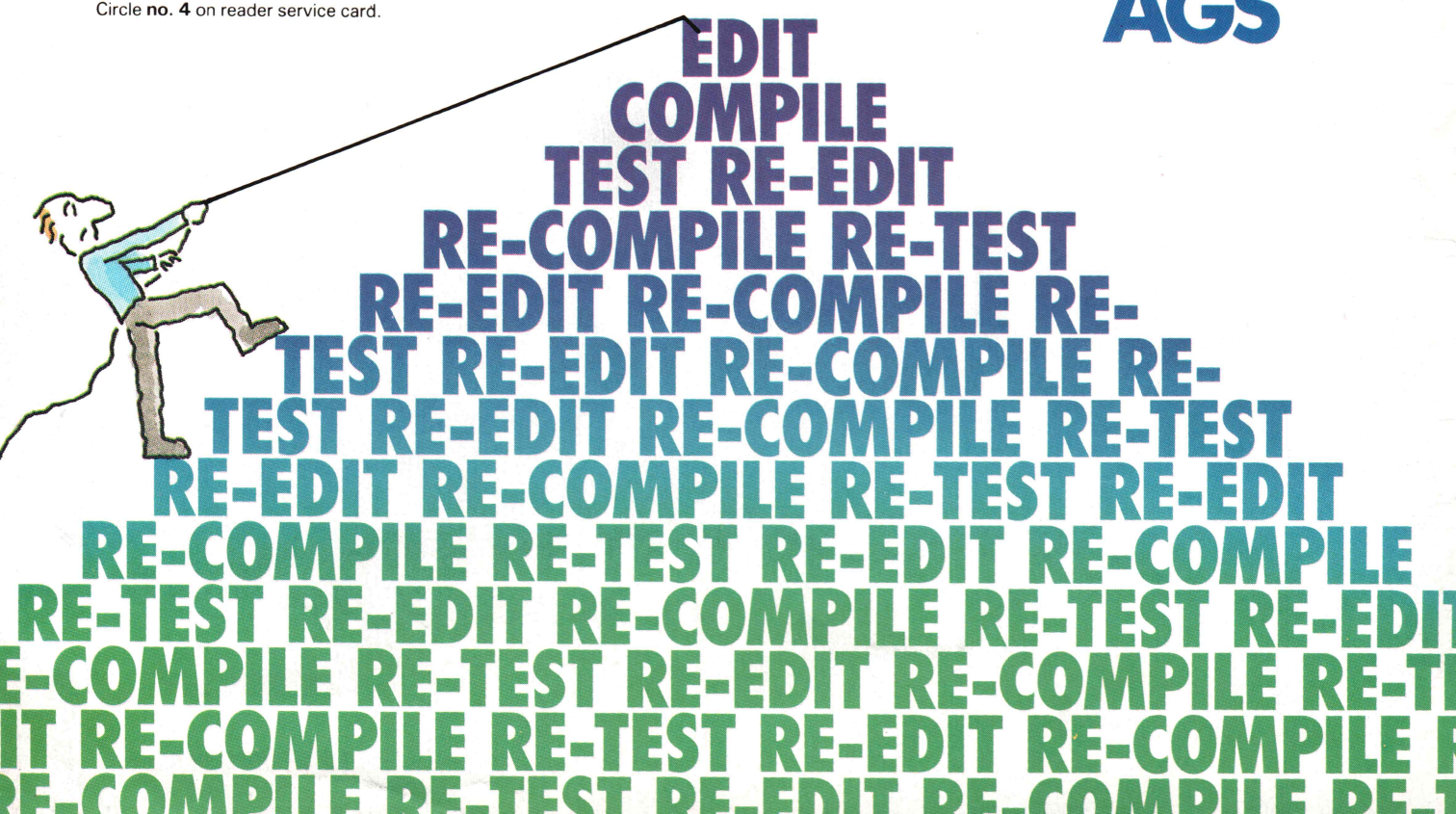

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Run Time
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Code produced suitable for ROM
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Set constant expressions
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Type casts
// = Concat for concatenation of all strings
Statements
Iterators (for data abstraction from CLU)
Assignment to string variables of differing lengths
Declarations
Otherwise (or else) in record declarations
Intrinsics
ReadIn(X:M)
Inc, Dec, Incl, Decl, from Modula–2
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Comparison (for equality) of record or array types
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June 1985
Volume 10, Issue 6

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The View from Mid-Year

These are the articles that generated the most reader response in recent months:

January, "Fatten Your Mac" by Thomas LaFleur and Susan Raab, and "Archiving Files with CP/M 80 and CP/M 86" by Ian Ashdown

February, Excerpts from *Fire in the Valley* by Paul Freiberger and Michael Swaine, and "CP/M Exchange," in which Bob Blum discusses buffered disk I/O

March, Richard Stallman's "GNU Manifesto," and Dave Cortesi's "Tour of Prolog"

April, Allen Holub's general purpose Quicksort routine in "C Chest"

May, "Solid Shape Drawing on the Commodore-64" by Richard Rylander

This month, Dean Gengle, our featured author, asks how we are to maintain democracy in an information age. There is more to telecommunications than baud rates and band widths! Special thanks to Ian Ashdown of byHeart Software and Steven Bellovin of AT&T Bell Laboratories for serving as referees.

Next month we deliver three hardware articles: "Build a Custom PC or Clone," "The Ultimate Parallel Print-Spooler," and the feature "Designing a Real-Time Clock for the S-100 Bus." In "16-Bit Toolbox," Ray Duncan presents MSDOS installable device drivers with an overview of the Unix device drivers which inspired them. Allen Holub, in "C Chest" offers an MSDOS directory utility which includes a multicolumn print utility. "Computer Calisthenics" will announce the winners and answers to Michael Wiesenberg's recent puzzle competition. We will also introduce a new column, "Mac Toolbox," to provide the background needed to write programs that really make use of the Macintosh's capabilities.

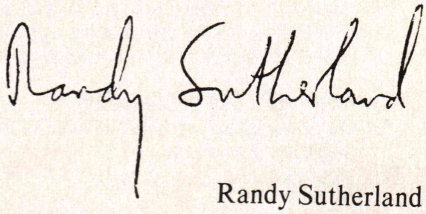
August, we'll C.

In September we'll take a practical look at an academic subject: Algorithms.

October Forth issue: Leo Brodie will report on the implications of the Novix chip for programmers. We also expect to cover Dr. Alan Winfield's Forth machine: an English job, with racing stripes. And we'll review Neon, a Forth-based, Smalltalk-like language for the Mac.

November: Programming Tools for Modula-2 Programmers.

December: Programmer's View of GEM.



Randy Sutherland
Editor

Referees

Ian Ashdown, byHeart Software
Steven Bellovin, AT&T Bell Laboratories

Dr. Dobb's Journal

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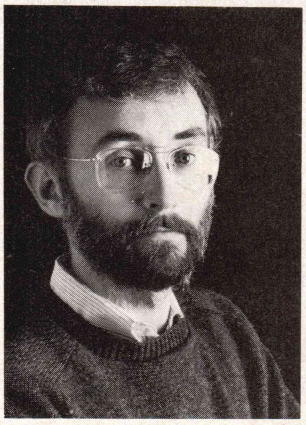

You'll find the answers to this month's Industry Awareness quiz upside down at the bottom of the page.

[1] How many computer books have been published in the last five years with the title *Up and Running*?

[2] How many C compilers are available for the IBM PC?

[3] How many IBM 360/75s were there installed in 1979? (Source: International Data Corporation.)

[4] How many DEC PDP-8s? (Source: ibid.)

[5] How many computer magazines folded in 1984? (Source: Marketing Technology.)

[6] What do you call a computer company that drives away people like Steve Wozniak and Andy Hertzfeld, pretends that the division keeping the company alive doesn't exist and thinks that it can make a machine a home computer or a portable by fiat? (Hint: it starts with an *A*.)

[7] Adam Osborne is predicting that within a year virtually all microcomputer software will sell for under $100 and Phillippe Kahn has been heard making predictions of wealth for Borland personnel that sound suspiciously like those we heard from Osborne Computer Company executives on *60 Minutes* a few years ago. Is Osborne emulating Kahn, or is Kahn emulating Osborne?

[8] By what ratio will Bill "The Cracker" Landreth's royalties for his book *Out of the Inner Circle* exceed the fine he paid when convicted of wire fraud? (Hint: his fine was half the dollar amount of the damage that he says the FBI did to his equipment in confiscating it.)

[9] What do you call an Association for DAta-Processing Service Organizations that responds to the vehement rejection by the Microcomputer Managers' Association of its copy-protection proposal (a plan that MMA threatened to respond to by boycotting participating vendors) by saying "Corporate America would find it hard to turn its back on the [software] these companies are offering"? (Hint: it starts with an *A*.)

[10] Back in February, San Francisco police lieutenant Thomas Suttmeier admitted that he had for the preceding two months had access to all computer files in the city's criminal justice system, including the public defender's files of defense strategies and files of the office that handles civilian complaints against the police. In fact, any police officer with access to the computer could have tapped into the files by typing "Tom's Menus." What can be done to prevent such abuses of power?

Michael Swaine

Michael Swaine

Answers: [1]: At least three. [2]: At least two dozen. We're reviewing them next month. [3] 25. [4] 34,665. [5]: 55. [6]: Arrogant. [7]: Neither. Entrepreneurs do not emulate, imitate, acknowledge predecessors or remember the past. [8]: By conservative estimate, 100:1. [9]: Arrogant. [10]: Be serious. We're talking about the *police* here. They wouldn't do anything wrong.

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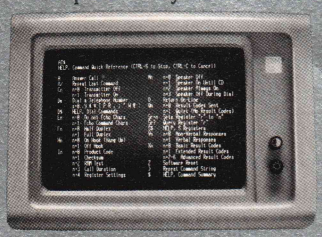

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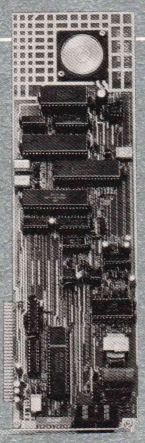

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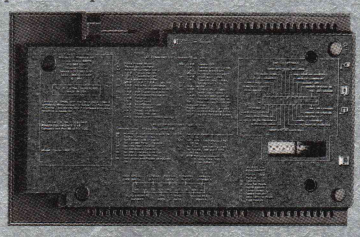

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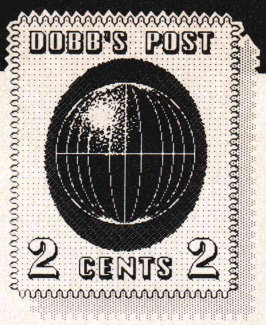

Prolog

Dear *DDJ*:

I enjoyed reading your March [1985, #101] issue, especially the article entitled "Programming In Logic." I am an avid believer in Prolog, hoping to see it continue to catch on in the U.S.

I'm writing to you in part to thank you for helping promote an understanding of logic programming and Prolog. I am also writing to let you know that while the table of sources of Prolog was a terrific addition to the article, it was not complete. Arity, a spin-off from LOTUS Development Corporation and recently funded by LOTUS, is in the business of building sophisticated Prolog tools and applications.

We take great pride in having built Arity/Prolog, a highly optimized and extended version of Prolog. We have two products available now: the Arity/Prolog Compiler and Interpreter and the Arity/Prolog Interpreter. We are also very excited about our upcoming products.

Sincerely,
Meredith Bartlett
Arity Corporation
336 Baker Avenue
Concord, MA 01742

Dear *DDJ*:

Congratulations on your Prolog issue. The articles, together with Dean Schlobohm's Tax Advisor program, provide an excellent introduction to Prolog.

I would just like to add, for your readers' information, the Quintus name to John Malpas' list of sources of Prolog. Quintus supplies a high-performance Prolog development system for the Sun workstation, and DEC Vax under Unix 4.2 and VMS. Quintus Prolog Release 1.0 features an incremental compiler, integrated Emacs text editor, comprehensive debugger, style checker, C interface, on-line help system, and a high degree of compatibility with DEC-10/20 Prolog and C-Prolog. In addition, Quintus distributes DEC-10/20 Prolog as an unsupported product.

Sincerely,
David Warren
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2345 Yale Street
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Capitalism vs. Stallmanism?

Dear *DDJ*:

Although I am no fan of Unix, I read Richard Stallman's "Manifesto" with delight. Here is a true adherent to the Hacker ethic! Mr. Stallman's militant advocacy is enhanced by his well-written arguments. Many may find points to dispute in his statement, but all will find it thought-provoking and interesting.

I wish him and his associates luck. The computer industry needs to be turned upside down every so often. Mr. Stallman seems just the fellow to do it this time. Gee—maybe I ought to reconsider my dislike of Unix—I'd hate to be left out of the fun when GNU arrives!

Yours,
James F. Glass
18653 Ventura Boulevard
Suite 351
Tarzana, CA 91356

Dear *DDJ*:

Richard Stallman's "The GNU Manifesto" in your March issue made me furious. I'd love to take 5 pages to dispute all of his 5 pages, but I'll confine myself here to 2 major points.

First, Stallman doesn't believe in property rights. As evidence on a small scale, note the omission of the usual "Unix is a trademark of Bell Labs" in his article, which was present in every advertisement in that issue. Stallman purposely omits this because he doesn't recognize their claim to the name Unix.

However, if it hadn't been for all the time and money invested by Bell Labs in development, then Unix would not be as widespread, popular, or valuable as it is today. If Unix had no value, then neither would GNU. (To see this, reread Stallman's article, substituting "Glorp" for "Unix" and see if he still makes sense.) In effect, Stallman is happy to take full advantage of Bell Labs' investment, with no recompense to them. Would you spend your time and money developing software, only to have Stallman copy it and give it away for free? I wouldn't. (In fact, Stallman wouldn't even give you the choice. He states: "the desire to be rewarded for one's creativity does not justify depriving the world in general of all or part of that creativity.")

Second, Stallman's explicit philosophy is socialist redistributionism. He states that "all sorts of development can be funded with a software tax." Stallman wants to tax *me* to fund *him* to develop software he will give away for *free*. Is this how you want your tax money spent? Not me.

Stallman states: "the fundamental act of friendship among programmers is the sharing of programs"; "good system software [should be] free, just like air"; what deserves a reward is "social contribution." In other words, the Good is what is social, shared, free. On the other hand, he states: "marketing agreements . . . forbid programmers to treat others as friends"; "users [are] at the mercy of one programmer or company that owns the sources"; software vendors

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"[extract] money from users of a program by restricting their use of it"; "a person who enforces a copyright is harming society." In other words, the Bad is what is individual, owned, bought, sold.

Stallman obviously prefers the former, which is characteristic of the Marxist ideals of the Soviet Union. Me, I prefer the latter, typified by the good old capitalist U. S. of A.

Stallman says he is looking for contributions. I would be delighted to offer a one-way plane ticket to Moscow.

Sincerely,
Robert Schwartz
P.O. Box 1637
Wakefield, MA 01880

Dear Richard:
Hurrah! Three cheers for GNU! Your proposal and the philosophy behind it are so refreshing, I almost couldn't believe what I was reading in this month's issue of *Dr. Dobb's Journal*. As you can see, I am ecstatic that someone is finally doing something about Unix.

Since about 1978 or so I have been going to Unix users' meetings, and I remember meeting Ron Cain at one of these meetings before he left SRI. I obtained a Unix Version 6 system about that time to run on a PDP-11/70 for a company contract. One of my colleagues spent a few nights writing some very useful programs; one was a combination nroff/troff marriage that output bit-mapped fonts on a Versatec printer. Another rotated the nroff/troff output by 90 degrees so that printed copy came out sidewise, but properly formatted on the Versatec 11×8½ fan-fold paper. With that system our little company was in business, and the number of reports and proposals done on that system was amazing. We had to repair the file system now and then, but that was a minor thing compared to the amount of work that got done.

Rather than waste your time with more of my nostalgia, I want to tell you that I have had in mind the same idea as you have proposed. After some of my friends were involved in the secure Unix kernel work at UCLA, I began to realize that it was in fact possible to write a Unix-like system that would not have the royalty problems that make Unix (even on micros) so ridiculously expensive. It is a crime that the micro community does not have access to the hundreds of programs written in C for Unix systems and that so many (inferior) wheels are being reinvented. I obtained a copy of the XINU book and have accumulated a library of articles on other people's experiences in porting Unix to new machines. I had just about everything I needed except a C compiler for my (don't laugh) Commodore 64. Recently one has been announced by Abacus Software, so I am getting all set.

The C64 is a short-term thing; I am looking forward to getting a 68000-based system soon. My motivation for wanting to do a system on the C64 was to be able to run good programs (e.g., a full-screen editor like Emacs) on that system. Memory limitations will obviously rule out multiple users, but if someone comes along with a hard disk interface, at least limited multi-processing would be nice. Already there are switchable memory banks available in 64K sections up to 512K.

For what it's worth, I would like to offer my help in your enterprise. This would most likely take the form of programming assistance. I suspect you will get a lot of other offers of help as well, now that you have "gone public" with your GNU concept. My resources are somewhat limited; however, it may be possible to get a Southern California "GNU Group" going. Perhaps you will spark enough interest to form a mailing list of volunteers.

Once again, I am glad someone like you has come along, and I hope there is some way I can help out.

Sincerely,
Rollin V. Weeks
7130 Marymount Way
Goleta, CA 93117

Dear *DDJ*:
After reading Richard Stallman's "Manifesto" [March 1985, #101], I felt compelled to respond. To begin, I am certainly not opposed to the idea of a public domain version of Unix, nor to public domain software in general. But my initial reaction to Mr. Stallman's sanctimonious outpouring was to feel rather insulted. I have been a programmer for about ten years now, and I don't believe that programmers are any more or any less greedy than others in this society. In the case of software companies supposedly making large sums of money selling copyrighted products, I rather doubt whether the programmers see very much of the profits.

I believe Mr. Stallman must be suffering from a few other fantasies besides that of a public domain Unix. He perhaps forgets that he is living in a capitalist society. Of course, everybody needs food, even more than free software. So food would be distributed for free, right? I have no doubt that farmers, food processing workers, supermarket clerks, truck drivers and others employed in the food industry will not let personal greed blind them to the logic of this argument. People need clothing, housing, medical care and education, too. All these things are necessities and as such should be guaranteed to everyone .... As for Mr. Stallman, I wonder how he can afford to devote so much of his time to this admirable project. Perhaps because his previous employer paid him such a fat salary that he can afford to forget about the dirty business of making a living for a little while.

I am afraid that I might sound almost as self-righteous as Mr. Stallman. I read *Dr. Dobb's* for its valuable technical information and for enjoyment. If any of your readers are concerned about moral or political issues, I would recommend that they subscribe to the *New York Guardian*. And I would also recommend that Mr. Stallman stick to technical matters, for which I am sure he is highly qualified.

Sincerely,
David Kettle
8 Milepost Place, #308
Toronto, Ont. M4H 1E1

Dear *DDJ*:
I read with excitement Richard Stallman's "The GNU Manifesto" until I reached his justifications for his approach. I feel torn because, on the

one hand, I applaud his objective, but, on the other, I cannot accept his rationale of why this is the proper approach.

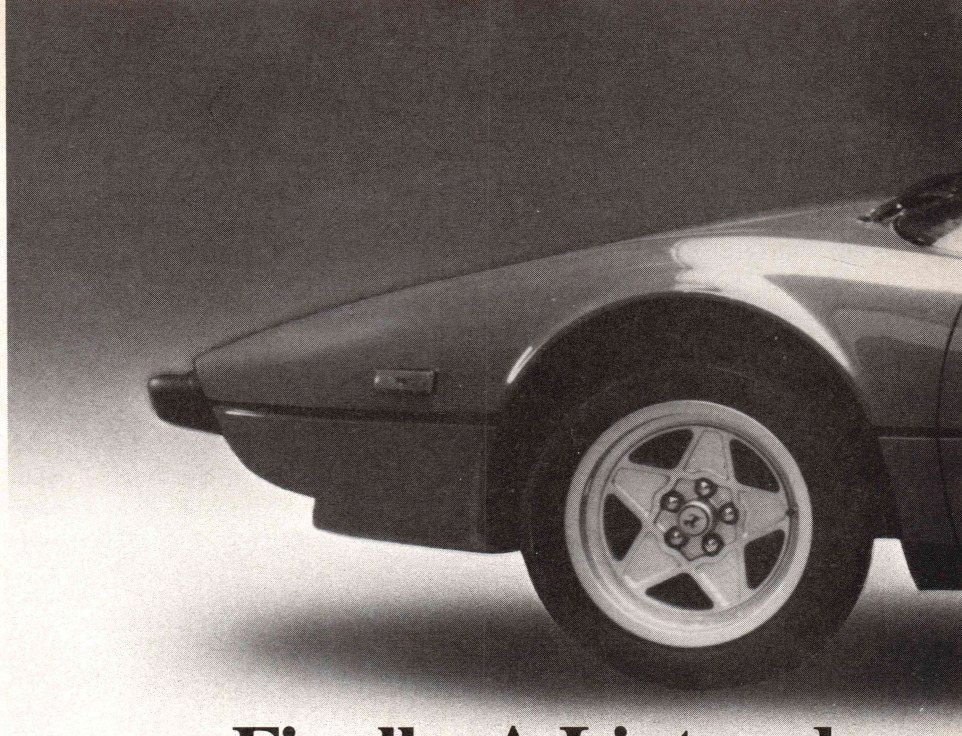
My problem is that he says that "social contribution" should be reward for an individual's creativity. Indeed, he claims that a personal reward is "destructive" because it deprives society of the potential benefits of an individual's creativity. I am a programmer and the owner of a business that sells software and from a selfish point of view would reject his arguments. But I am also a free market advocate and I reject his statements on philosophical grounds which I will attempt to enumerate.

First the wealth of society is increased whenever individuals trade freely. If I charge $100.00 for a program and you freely decide to buy the program, we are both richer. I have my $100.00, which I value higher than the copy of the program, and you have the program, which you value higher than the $100.00. If we were not both richer, then one or both of us would not have entered into the trade.

To say that this is "destructive" to society because, by charging, I deny the benefits of my program to society, is to say that whatever one creates does not belong to him, but belongs in some larger sense to society, and, therefore, to deny it to society is being "destructive."

In a narrow sense Mr. Stallman is right. If Lotus Development gave away "Lotus 1-2-3" instead of charging for it, we would all use it and "society" would be richer. The problem is that Lotus Development would never have created "Lotus 1-2-3" in the first place. Further, the hundreds of others who think they can do it better than Lotus would not go to the effort of attempting to make a better "Lotus 1-2-3" without the promise of financial reward. In this sense society would be poorer because of the free software.

I believe that an individual's physical or intellectual product is his own. Unknowingly, he furthers the general good by selfishly trading it for the most he can get for it. Only a lawyer would say that one's original idea is not his own. Only a dictatorship



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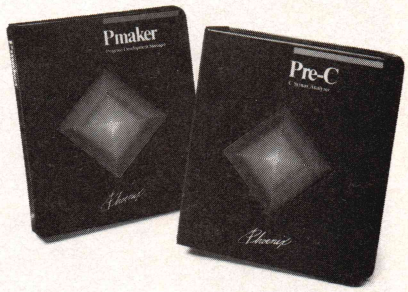

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would steal it from the author.

The proof is in the pudding. Today we see hundreds of thousands of programmers working at what they love and doing it to maximize their own rewards. The individual is supreme. The marketplace decides who wins and loses. Society benefits by this enormous effort. If we follow Mr. Stallman's philosophy, we have to elevate "society" to a higher level than the individual. This I cannot do. Indeed, wars have been fought and blood spilled over these very ideas.

Yet, I wish him every success with GNU. I don't know how he keeps food on the table during his efforts, but as he said, his reward is in his love of programming, the pride of seeing his work being used, the recognition of his peers, and just knowing he has contributed something to the world. For some, this is more important than money. Indeed, if given independent means many more would follow the same path.

I hope he succeeds with GNU (I love his recursive name!) because for all the reasons he mentions, I could be a beneficiary. I also wonder whether the success of a "free" operating system will close the door to other operating systems that might be developed if there were some money to be made. He may find that in succeeding in his quest, in the long run he may hurt the "society" that he was hoping to enrich. On second thought, there is nothing to worry about, for if there is a need for a better operating system than GNU in the future, people will be willing to pay for it.

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BU Patched

Dear *DDJ*:

I read Jim Rosenberg's Letter to the Editor [March 1985, #101] regarding my article "Archiving Files with CP/M-80 and CP/M-86" [January 1985, #99], and would like to respond to his comments regarding BU and CP/M.

Mr. Rosenberg is correct in stating that the BDOS of CP/M v2.2 does *not* reset file attribute bit t3-prime whenever a file is opened, written to and closed. In this matter I admit to being mistaken. I can also confirm that Dave Cortesi's book *Inside CP/M* is also wrong in stating (p. 222) that "the BDOS sets t3' to 0 whenever it updates a directory entry, that is, whenever the data map of an extent is altered."

However, Mr. Rosenberg chose to ignore the second part of my statement: that a directory entry is changed if it is renamed (or created). In this case the BDOS most definitely sets t3-prime to zero, and it is this fact upon which depends the success of both BU and (presumably) QBAX. This can be demonstrated by setting the file attribute t3-prime of a file with a disk utility, using either the built-in "REN" command or BDOS function 23, "Rename File," to change the file's name, and then examining t3-prime again.

To quote Mr. Rosenberg: "Our own product, QBAX, will function without patching for programs such as word processors and compilers that change files by rewriting them

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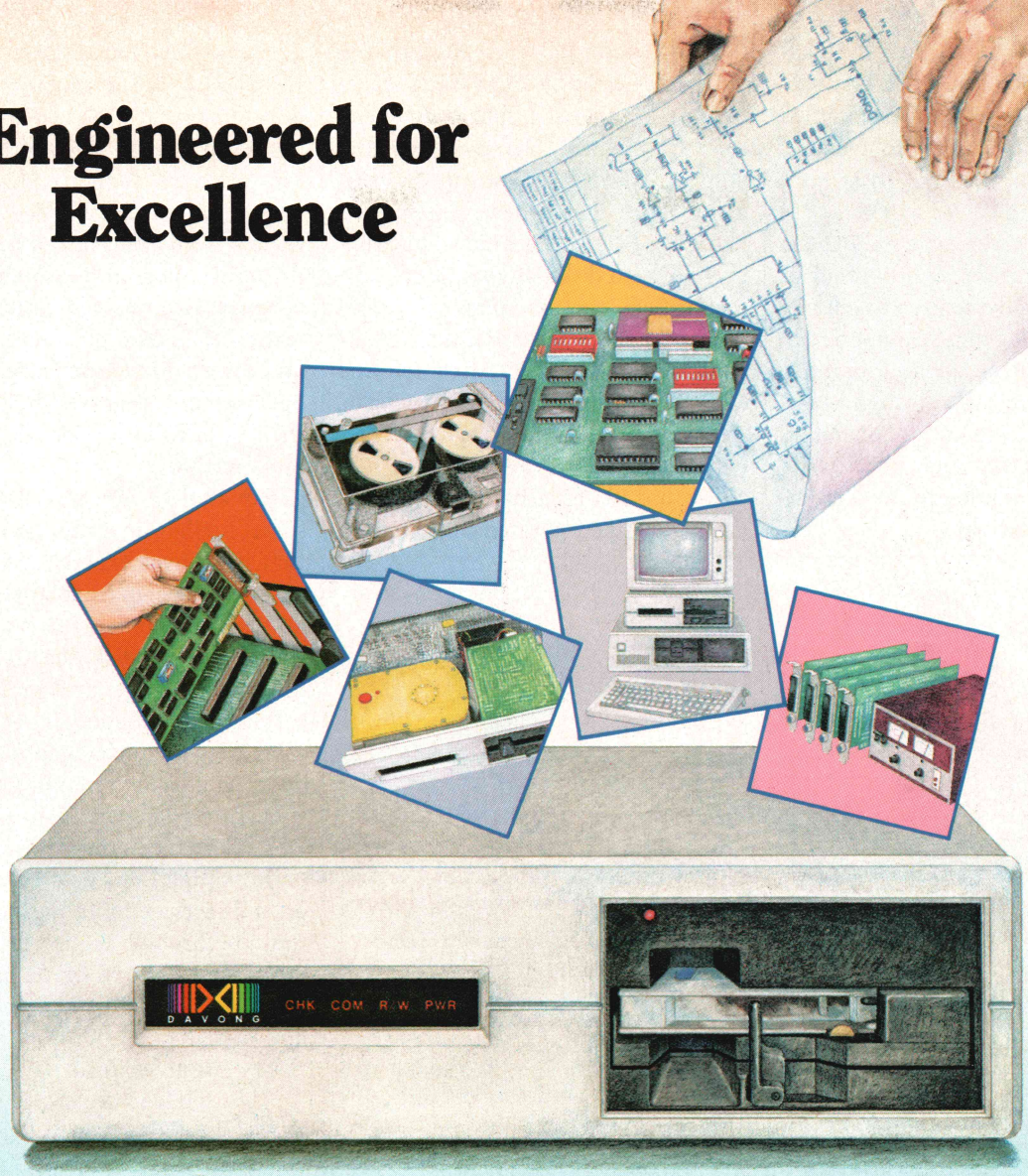

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from scratch." This is exactly what BU will do. Since "BU is almost useless under 2.2 unless BDOS is patched to install support for the archive bit," cannot the same be said for QBAX under a standard CP/M BDOS?

The answer is of course no. BU is a very useful program, as a number of satisfied users have written to tell me. Its one failure is that it cannot detect files that have been updated in place (i.e., changing records through BDOS random access calls or by appending records via BDOS sequential write calls). To do so would require a modified operating system.

QBAX, according to a review by David Fiedler in the October 1983 issue of *Microsystems*, is a fine commercial software product. The review covered QBAX1, which does not support hard disks. Since that review, Amanuensis has released QBAX2, which offers support for hard disks, automatic split file restoration, version numbering and date stamping. Both products apparently include the BDOS patch, referred to by Mr. Rosenberg, that implements the archive bit feature for those files updated in place.

I wrote BU as a basic utility program that incorporated and demonstrated a relatively obscure feature of CP/M v2.2. Readers were invited to add their own enhancements, since space limitations prohibited including features such as QBAX1 and QBAX2 offer. If the *Microsystems* review is anything to go by, I would probably recommend the QBAX products to a business user of CP/M, rather than BU. In this matter, I agree with Mr. Rosenberg. I do not believe that businesses should entrust their data to unsupported public domain utilities.

Regarding CP/M's PIP utility, some further investigation revealed that it behaves exactly as you would expect under the explanation given above. When a new file is created on the destination disk, the archive bit is initially zero. The archive bit can be set by BU or another utility, and thereafter is unchanged by any file operation *except* renaming the file.

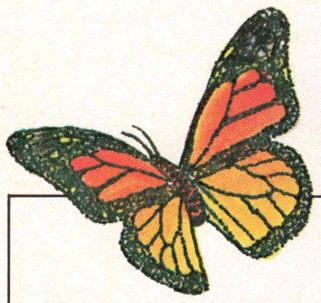
In summary, I wish to thank Mr. Rosenberg for his critique of my article, although I feel he did *DDJ*'s readers a disservice by failing to mention that the archive bit is reset when a file is first created or renamed, and by strongly implying that BU does not work.

Ian Ashdown
byHeart Software
2 - 2016 West First Avenue
Vancouver, B.C. V6J 1G8
Canada

Dear *DDJ*:

We noted with interest Ian Ashdown's BU program published in the January (1985, #99) *DDJ*. We also noted, as Jim Rosenberg of Amanuensis reported in a letter in the March issue, that the "archive bit" t3' is not automatically cleared by the BDOS on file writes or renames.

After examining the BDOS we came up with a patch to accomplish this under CP/M 2.2. With the patch installed, any time a file is written to, either randomly or sequentially, the "archive bit" will be cleared to zero. We have used this with a number of different programs including word processors, SuperCalc and Microsoft BASIC (including writing a single random record) and have encountered no problems with it.



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Since a number of your readers may be interested in having this facility, I am enclosing a printout of the patch (see Listing, below). This patch assumes that the patch code is located outside of the BDOS, probably in the BIOS. The changes to the BDOS can be made by the BIOS on each warm boot, if necessary, though there are other ways to accomplish this.

Before making the patches to the BDOS, be sure that code to be replaced matches that shown in the enclosed patch (the original code is commented out in the patch).

One other approach which we have used to implement the patch is to install it directly into the BDOS source. We have used C. C. Software's excellent CP/M Source Code Generator to create the BDOS source (we have this software available, as well as our own EUREKA! disk cataloger). We then substituted Z80 instructions in enough places to gather the space we needed for the patch and reassembled the BDOS and patched it directly onto the disk.

We hope that this patch will make BU even more useful to your readers.

Bruce Haanstra, President
Mendocino Software Co.,
P.O. Box 1564
Willits, CA 95490

DDJ

Letters Listing (Text begins on page 8)

```
;Desc:Patch to CP/M 2 BDOS to clear update flag on close or rename of a file
;Date:02/02/85
;Time:13:51
;
; The purpose of this patch is to clear the update flag (8th bit of t3) when a
;  file that has been changed is closed.  Part of this patch file will also
;  clear the update flag on a rename.
;
BDOSBASE        EQU     0D800H          ; *** SET THIS TO THE ADDRESS OF THE
                                        ;     BASE OF YOUR BDOS ***

patcharea       equ     00000           ; *** PUT THE ADDRESS WHERE YOUR PATCH
                                        ;     CODE IS LOCATED HERE BEFORE
                                        ;     ASSEMBLY ***

updflg          equ     11              ; offset to update flag byte in fcb
                                        ; 11=t3' (archive bit)

; patch to rename
        org     BDOSBASE+822h
        jmp     patch1
;
; was   lxi     d,16
;       dad     d
;       mov     m,a


; patch to clear update flag on a file that has been changed
        org     BDOSBASE+91Ch
        jmp     patch2
; was   JMP     BDOSBASE+810h   (update1)

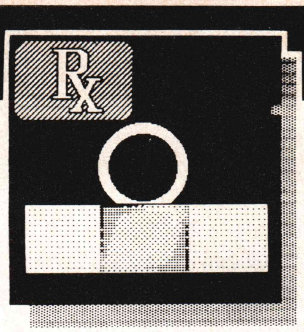
;
        org     patcharea
;
; ***** UPDATE FLAG PATCH *****
;  01/06/85 - by BWH
;  this patch forces the directory entry being written to have its update
;   flag bit reset to 0 so FD and MDIR can handle ALL updated files.
;

patch1:                         ; RENAME patch
        lxi     d,16                    ; move over to desired name
        dad     d
        mov     m,a                     ; keep the same user number
        call    clruflg                 ; clear the update flag
        jmp     BDOSBASE+827H           ; (chgnam1) go back and continue

patch2:                         ; UPDATE flag patch
        call    BDOSBASE+55Eh   ; (fcb2hl) get address of fcb in dir buffer
        call    clruflg         ; offset to FD update flag byte (0-11) of fcb
        jmp     BDOSBASE+810h   ; (update1) do original stuff
;
; 01/27/85 - broke out clearing of update flag so rename can do it too
;       IN    -> HL=address of base of FCB with flag to clear
;       USES -> A, HL, DE
;
clruflg:                        ; clear update flag routine
        lxi     d,updflg        ; offset to FD update flag byte (0-11) of fcb
        dad     d
        mov     a,m             ; get the current byte
        ani     7FH             ; clear 8th bit
        mov     m,a             ; and put it back
        ret
;
;
```

End Listing

DR. DOBB'S CLINIC



by D. E. Cortesi

Printer Out of Shadow

In the April column, we asked for help finding competent maintenance for our Diablo printer, but we wrote that column back in February, and the problem wouldn't wait. We posted the same query on several local RBBSs (and very glad we were that the Oxgate, PicoNet, and Simms boards exist). One Eugene Jones came through with a recommendation of The Printer Works (1961 Alpine Way, Hayward, CA 94545; (415) 887-6116). And they did the job: made an informed diagnosis; discussed it with us, explaining exactly what they would do and what it would cost; then did the work. They were thoroughly professional, helpful, and prompt. May they get every broken Diablo in Silicon Valley.

But our problems getting the Diablo fixed have made us wonder: What else is hard to get fixed? Who else is doing a good job fixing things? If you've had maintenance adventures—with happy endings or otherwise—why don't you describe them to us? Especially tell us about repair people who know their stuff. Let us in on the scams, too (with enough horror stories, we can revive "Dobb's Ex Machina"), but it would be super if we could point to good repair services in every major city.

Watt Duzzit Dew

We asked in January David Tilton asked us: What does this short Z80 assembly routine do?

```
BTS:
    cp    (hl)
    ret   z
    rl    L
    djnz  BTS
    ld    L,0
    ret
```

Only Thomas Cage of Crestview, FL, attempted to give us an answer (yea, Tom!), and while he got the essence of it, he was wrong in detail (boo, Tom!). Here is how Tilton described it.

"[The routine] actually outperforms the CPIR instruction of the Z80 in searching a list of bytes for a match by using a binary rather than a linear search, but the restrictions on the sequence of the list and its placement in memory make it less than attractive.

"On entry, A contains the byte to search for, B contains the number of levels in the binary tree, and HL points to the root of the binary tree. One of the unfortunate restrictions is that the value of L for the root must be 01h. Since the value of H remains constant, it is the value of L on return that indicates the result.

"It is helpful to think of the list as a byte array indexed by L. We start with a comparison. If there is a match, the second instruction returns with L indicating where the match occurred.

"If there was no match, the value in the tree was either too large or too small. The carry flag will be set if it was too large. The next instruction multiplies the contents of L by two and, if the carry flag was set, adds one. The DJNZ instruction checks for another level in the tree and, if there is one, loops to check the already-selected node in it. If there is not another level, L is set to zero to indicate that the byte sought was not in the tree.

"There are many disadvantages to this arrangement. It is inflexible. For one thing, a full tree must be maintained; that is, the size of the tree must always be some power of two less one. It is significantly faster than CPIR only for the larger trees. Furthermore, if you can spare a full page of 256 bytes [to hold the tree] then there is an even faster way of doing the same thing:

```
BTL:
    ld    L,A
    ld    L,(HL)
    ret
```

This is, of course, simply a byte look-up table. I thought I was being really clever with my BTS routine, but it turns out to be virtually useless."

Oh, now, cheer up. You got deep into binary trees, right? It's very profound that the successive carry-bits shifted into L are a record of the path through a tree to the desired node, where one means "go left" and zero means "go right." The binary number that defines the path to a node is a unique label for that node; it's basically a "Dewey Decimal Number" for the node.

There's a discussion of this in Knuth's Volume 1, Section 2.3 (especially see the answer to Exercise 15, p. 315). There also is a connection to data compression: if the compared values were wider than a byte, their binary node labels would be a compressed representation of them.

Watt Dozen It Dew

OK, faithful readers, you didn't do too well on Tilton's puzzle; perhaps you can do better with one from David Ross, of Iowa City, IA. He sends the BASIC code you can read in Listing One (page 18). "In theory," he says, "it does something quite remarkable. In practice, it doesn't do much of anything: it is extraordinarily sensitive to roundoff errors. Question: what ought it to do, and to what extent can it be made to work?"

Now, Tilton sent a full explanation

of his puzzle. Ross did not. That means (since the Intern hasn't a clue) that if you don't figure it out and explain it, nobody will ever know the answer.

Random Probing

In February we showed a simple generator of pseudo-random numbers (a PRNG, pronounced "prang"). We're getting mixed feedback on that; at least one reader has written to say it's no good. It would be nice if someone would subject it to some rigorous testing and tell us.

In fact, the letters we are seeing indicate a lot of ignorance about what's good in a PRNG and how to test one. Add to that a paper that Mike Swaine ran across: "Random Number Generation in Microcomputers" by Modianos, Scott, and Cornwell in *Interfaces*, Vol. 14, No. 4 (July-August 1984). We aren't familiar with *Interfaces*; it appears to be a publication of The Institute of Management Sciences.

Anyway, Modianos, et al., studied the characteristics of the PRNGs in various micro BASICs. The net of their findings is "that the random number generators which are intrinsic to the Apple II+ and IIe (using either Applesoft BASIC, Integer BASIC, or CP/M BASIC), the Osborne Executive, and the IBM PC are so flawed that we cannot recommend their use for simulation studies." The only acceptable PRNGs they found were in the HP-86, Apple III, and (oddly) the TRS-80 model III. Plus one for the Apple published by Hare, Faulkner, and Sparks in *Call APPLE*, Vol. 6, No. 1.

These authors apparently expended a lot of time and CPU cycles testing PRNG; unfortunately, they don't discuss their methods in any detail. Sure, that subject has been covered many times before, but not for some years in this magazine. Volunteers?

Object Module

By way of filling up this column, we present a module of C code that has helped us make some quick-and-dirty programs. Sometimes it's easier to do things if you have the ability to allocate a lot of small objects and free them again in any order. In *The C Programming Language*, Kernighan and Ritchie described a pair of functions, alloc( ) and free( ), to do just that. Probably these are in most C libraries.

The compiler we use implements an alloc( ), but contains no free( ). Alloc( ) alone gives the essential ability to allocate chunks of storage for buffers and what-not. But we wanted to make dozens or hundreds of little objects and then discard them again. So we did what you'd do: we rolled our own.

The module for dispensing objects appears in Listing Two (page 18). It duplicates the functions of alloc( ) and free( ), including quite a bit of validation to guard against bugs in

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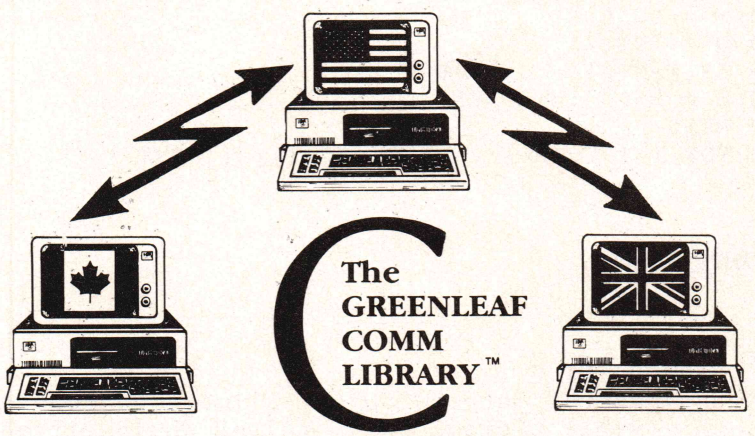

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the using code. It adds the useful functions of objmax( ) and objtrim( ), which allow you to size an object to match the data it will hold.

The method it uses is not that of Kernighan and Ritchie, but rather an old scheme that you may not have seen before: chaining adjacent blocks by fencing them in with length-words.

The more we use C's #define, the more impressed we are with the flexibility it gives. In the Object module, we used it to define an adjective, WORDAT, to stand for the awkward cast required to say, "the unsigned integer in storage where this character pointer points."

The Object module is definitely written for 8-bit machines; it relies on 16-bit addresses stored in 16-bit integers. The first step in making it portable would be to convert all the hex constants to #defined names. Also, it would be more efficient if it started the search for a free block at the point where it last found or freed one. You might enjoy making those improvements.

The performance of this design won't differ a great deal from that of Kernighan and Ritchie. You might enjoy analyzing the two and working out which is faster, under the assumption of a high turnover of many, small objects.

DDJ

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Dr. Dobb's Clinic **(Text begins on page 16)**

Listing One

```
100 REM BASIC PUZZLE BY D. ROSS
105 REM MODIFIED FOR MBASIC BY DEC
110 DEF FNL(X)=LOG(X)/T
120 INPUT "K=",K : DIM A$(K+1)
130 FOR I=1 TO K+1 : A$(I) = "0" : NEXT I
140 T = LOG(10)
150 Z = ASC("0")
160 A0 = K*FNL(2)
170 B = 1
180 WHILE B > 0
190 A = A0+FNL(B)
200 N = INT(A)
210 IF N<0 THEN GOTO 280
220 L = A-N
230 X = 10^L
240 D = INT(X)
250 A$(K-N+1) = CHR$(D + Z)
260 B = B-10^(N-A0+FNL(D))
270 WEND
280 FOR I=1 TO K+1 : PRINT A$(I); : NEXT I
```

End Listing One

Listing Two

```
/*
        OBJECT.C
        general purpose object-allocation module
        (8-bit systems only, relies on 16-bit addresses)

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An "object" is a block of storage of at least two bytes.
Functions in this module manage a pool of storage to
allocate and reclaim objects.

unsigned objinit(u) unsigned u
        Initializes a storage pool of size u, returning the
        size of the largest object that may be allocated.
```

(Continued on page 20)

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Listing Two

```
        If called a second time, does nothing and returns the
        size of the largest object that can now be allocated.

unsigned objmax()
        Returns the size of the largest object that can be
        allocated from the storage pool as it is now.

char *objget(u) unsigned u
        Allocates an object of size u and returns its address,
        if possible.  If it can't, it aborts the program.

void objfree(p) char *p
        Frees the object addressed by p, which must have been
        allocated by objget().  If it wasn't, or if it is now
        free, or if it's been damaged, the program is aborted.

unsigned objsize(p) char *p
        Returns the size of the object addressed by p.  Aborts
        if *p is not a valid object.

void objtrim(p,u) char *p; unsigned u
        Trims the object addressed by p back to have size u,
        releasing excess space.  Use in a sequence like,
                p = objget(t=objmax());
               ...process data *p to size u, u <= t...
                objtrim(p,u);
        Aborts if *p isn't a valid object or if its size is
        less than u.

void objprt()
        Compiled only if DEBUG is defined, this function
        prints a map of object-space on stderr.

Allocation is first-fit.  Garbage is melded as it is created.
An object is allocated as an even number of bytes L, fenced in
by two words WWWW:

                  A     B               C     D
 ...object (WWWW)(WWWW)<== L bytes ==>(WWWW)(WWWW) object...

Words WWWW are essentially 2+L, where L is the length of the
object they bound.  The low-order bit is the in-use flag.
If (W & 0x0001), the object is active; if not, it is free.
The value K == (WWWW & 0xfffe) == 2+L is used to chain from
block to block.  For addresses A,B,C, and D as shown, A+K->C,
B+K->D, B-2->A, D-2->C, D-K->B, etc etc.  Address B is the
object's address, returned by objget() and given to objfree.

The whole storage pool is bounded by two sentinel words, 0003.
These appear to be active blocks with K=2, hence L=0, and stop
a scan over the pool.

*/
#include "a:stdio.h" /* for error messages */

/*efine DEBUG 1*/ /* or don't -- to exclude objprt() */


 #define WORDAT *(unsigned *)     /* using "char *" ptrs for words */
 #define VOID /* not supported in Aztec C */
 static char *objbase = 0,        /* base of storage pool, uninitialized /
            *objtop;             /* upper limit, for integrity checks */
static unsigned maxobj,          /* largest possible object */
```

```
                j,k;            /* scratch words */
static char *p, *q,             /* scratch pointers */
        minit[] = "Objinit",    /* abort-message parts */
        mget[] = "Objget",
        mtrim[] = "Objtrim",
        mvali[] = "Object validation",
        mpool[] = "Object pool damage";

VOID    objinit(u)
        unsigned u;
{
        if (objbase) return(objmax());

/* ensure an even number of bytes in the entire pool */
        u = (u==0xffff) ? 0xfffe : (u + 1) & 0xfffe;

/* set out 4 bytes for sentinels, 4 for first 2 WWWW words */
        maxobj = u-8;

/* ensure a reasonable size of pool, allocate it */
        if (248 > maxobj)
                objerr(minit,1);
        if (NULL==(objbase = alloc(u))
                objerr(minit,2);

/* set up sentinel words 0003h at ends of pool */
        objtop = objbase + u - 2;
        WORDAT objbase = 0x0003;
        WORDAT objtop = 0x0003;

/* fill pool with a single free object */
        objbase += 2;
        k = maxobj+2;
        WORDAT objbase = k;
        q = objbase + k;
        WORDAT q = k;

        return (maxobj);
}

char *objget(u)
        unsigned u;
{
/* eliminate cases of zero and too-big sizes */
        if (u==0) objerr(mget,1);
        if (u>maxobj) objerr(mget,2);

/* ensure even length, establish enventual K == L+2 */

        k = 2 + (u = (u + 1) & 0xfffe);

/* Scan to the top sentinel, looking for the first free
   object longer or equal to the requested size.  The pool
   is vulnerable to damage --  be very suspicious and test
   every link in the chain before using it. */
        p = objbase;
        while (0x0003 != (j = WORDAT p))
        {
                if (0==(j & 0x0001)) /* free */
                        if (j >= k) break; /* good size */
                q = p + 2 + (j & 0xfffe);
                if ((q <= p)||(q > objtop))
                        objerr(mpool,1);
                p = q;
        }
/* if we hit the sentinel, the requested size is not available
   (could return NULL here instead of aborting) */
        if (j==0x0003) objerr(mget,3);
```

(Continued on next page)

Listing Two

```
/* set p->low WWWW, q->high WWWW, validate block */
        q = p + j;
        if ((q <= p)||(q > objtop))
                objerr(mpool,2);

/* if the wasted space in this block would accomodate
   another object of 4 bytes or more, split off the
   high end as a new, smaller free object */
        if (j > (k+8))
        {
                j = j-k-2; /* j=WWWW of excess object */
                WORDAT q = j;
                q -= j;
                WORDAT q = j;
                q -= 2;
                WORDAT q = k;
                WORDAT p = k;
        }

/* activate chosen block, return address of data */
        WORDAT p += 1;
        WORDAT q += 1;
        return (p+2);
}

unsigned objsize(ob)
        char *ob;
{ /* This is mostly an internal subroutine.  It validates
     a user-supplied object-pointer, leaving static globals
     p, q, and k set up so that p->(WWWW) ... q->(WWWW)
     and k== WWWW & 0xfffe.

        p = ob-2;

/* address must fall within in pool, */
        if (p < objbase) objerr(mvali,1);
        if (p > objtop) objerr(mvali,2);

/* ..must have active lower WWWW word, */
        k = WORDAT p;
        if (0==(k & 0x0001)) objerr(mvali,3);
        k--; /* strip active bit */

/* ..showing size of L=2 or more, but not more than max, */
        if (k<4) objerr(mvali,4);
        if (maxobj < k) objerr(mvali,5);

/* ..which must yield a valid upper-WWWW address, */
        q = p + k;
        if ((q <= p)||(q > objtop)) objerr(mvali,6);

/* ..and the upper and lower WWWWs must match */
        if (WORDAT p != WORDAT q) objerr(mvali,7);

/* object is valid, return its data size */
        return (k-2);
}

VOID    objfree(ob)
        char *ob;
{
/* use objsize() to set up p, q, k and validate block */
        objsize(ob);
```

(Continued on page 24)

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Listing Two

```
/* object is valid, make it free */
        WORDAT p = k;
        WORDAT q = k;

/* if object next above is free, meld with it.  Afterward
   and regardless, ensure that p->KKKK... q->KKKK */
        q += 2;
        j = WORDAT q;
        if (0==(j & 0x0001))
        {
                k = k + j + 2;
                WORDAT p = k;
                q += j;
                WORDAT q = k;
        }
        else q -=2;

/* if block next below is free, meld with it, too */
        p -= 2;
        j = WORDAT p;
        if (0==(j & 0x0001))
        {
                p -= j;
                k = k + j + 2;
                WORDAT p = k;
                WORDAT q = k;
        }
}

VOID    objtrim(ob,sz)
        char *ob;
        unsigned sz;
{
/* validate object, ensure call is to reduce it not enlarge it */
        j = objsize(ob);
        if (sz > j) objerr(mtrim,1);

/* ensure new size will be even */
        sz = (sz + 1)&0xfffe;

/* we will create a new, free object in the high end of
           the present one --  its k is k-sz-4. */
        j = k - sz - 4;

/* if that block doesn't amount to 8 bytes of data, forget it */
        if (j <= 10) return;

/* the k of the existing block will become sz+2 */
        k = sz + 2;

/* create the trimmed block, including active bit */
        WORDAT p = k+1;
        p += k;
        WORDAT p = k+1;

/* create the freed block (no active bit) */
        p += 2;
        WORDAT p = j;
        WORDAT q = j;

/* if its upper neighbor is free, meld them */
        q += 2;
```

```
        k = WORDAT q;
        if (0==(k & 0x0001))
        {
                j = j + k + 2;
                WORDAT p = j;
                q += k;
                WORDAT q = j;
        }
}
unsigned objmax()
{
        p = objbase;
        k = 0;

/* scan the whole pool to find the largest free object. */
/* be suspicious, validate all chain links as we go. */
        while (0x0003 != (j = WORDAT p) )
        {
                if (j & 0x0001)
                        j &= 0xfffe;
                else
                        if (k < j) k = j;
                q = p + j;
                if ((q <= p)||(q > objtop))
                        objerr(mpool,3);
                p = q+2;
        }
        return (k-2);
}

VOID    objerr(m,n)
        char *m;
        int n;
{
        fprintf(stderr,"\n\n%s error #%d\n",m,n);
        exit();
}

#ifdef DEBUG

VOID    objprt()
{
        fputs("\n\nmap of allocation space...\n",stderr);

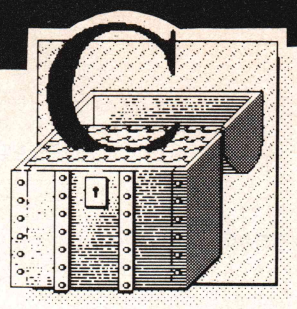
/* display what should be lower sentinel of 0003, and its address */
        p = objbase-2;
        fprintf(stderr,"%04x->%04x\n",p,WORDAT p);
        p +=2;

/* display bounds and WWWW words of each block to upper sentinel */
        while(0x0003 != (j = WORDAT p))
        {
                q = p + (j & 0xfffe);
                k = WORDAT q;
                fprintf(stderr,
                "%04x->%04x ... %04x->%04x\n",
                p, j, q, k);
                if ((q<=p)||(q > objtop)) break;
                p = q+2;
        }

/* display upper sentinel unless chain was broken */
        if (j == 0x0003)
                fprintf(stderr,"%04x->0003\n",p);
        else
                fputs("...stopped for invalid chain\n",stderr);
}
#endif
```

End Listings

Queues and Bit Maps



by Allen Holub

Queues

I've never been happy with a store-bought word processor. I cut my teeth on vi and nroff on a Unix system, and I've yet to find an acceptable commercial version of either that will run under MSDOS.

Because I had an editor that I could live with, not having nroff was my greatest problem. None of the versions of nroff from users groups were acceptable; they invariably were subsets of the real thing, often loaded with bugs, and at least one of them (roff4) was formatted so poorly that it was unmaintainable. The writers of these programs also took considerable liberties with nroff's instruction set.

So, being a masochist, I wrote my own nroff. In the course of this project, I added several useful functions to my library and these functions will turn up in this column from time to time. This month we'll look at the queue manager .

A queue is a FIFO (first in, first out) data structure. The first object to be enqueued is also the first object to be dequeued (unlike a stack where the first object pushed is the last object popped).

The rate at which objects are enqueued can be higher than the rate at which they are dequeued, as long as you never allow the queue to get full. Therefore, you can use queues to implement type-ahead in character I/O routines and the like. The interrupt service routine that talks to the keyboard UART puts characters into the queue, and getc or its system equivalent takes the characters out of the queue. As long as the queue never fills up, getc doesn't have to keep up with the data rate at the UART.

Queues have other uses. In multitasking operating systems, they hold pending messages while a task is busy. In a word processing application (like nroff), they're used for line filling. Input text to nroff is unformatted: there are a random number of words on a line. Nroff collects words until it has enough to fill an entire line, then it prints the collected line. My version of nroff enqueues characters until it has collected one too many words. It then dequeues all but the last word to produce an output line.

Listing One (page 31) contains a package of queue management routines; you need to declare a pointer to a QUEUE somewhere in your program to use them. Like a FILE, a QUEUE is a structure maintained by the queue manager. However, also like a FILE, your program need know nothing about the details of queue management or the contents of this structure. I usually typedef a QUEUE as a character pointer when I use it. Now let's turn to the various routines.

```
typedef char *QUEUE;

QUEUE *makequeue( qsize, objsize )
int qsize, objsize;
```

Makequeue( ) is the equivalent to fopen( ). "Qsize" is the size of the queue in objects (not bytes), and "objsize" is the size of a single object in bytes. You can make a queue of anything; even a queue of structures is permissible. Like fopen( ), makequeue( ) returns a pointer that must be passed to all the other queue management routines. A zero is returned if there isn't enough memory to make the queue.

```
del_queue( qp )
QUEUE *qp;
int empty;
```

Del_queue( ) deletes a queue created with a previous makequeue( ) call. Qp is the pointer returned by that makequeue( ) call. This routine *only* deletes empty queues. If you need to delete a queue that isn't empty, use free(qp); a one is returned if the queue is deleted, and a zero otherwise.

```
enqueue ( obj, qp )
char *obj;
QUEUE *qp;
```

enqueue( ) puts an object into the queue. "Obj" points at the object to be enqueued. Alhough it's declared as a character pointer, obj actually can point at anything. "Qp" is a pointer to the queue itself, as returned from a previous makequeue( ) call.

```
dequeue ( obj, qp )
char *obj;
QUEUE *qp;
```

Dequeue( ) is the opposite of enqueue( ). It takes an object out of a queue pointed to by "qp" and puts that object at the memory location pointed to by "obj."

```
car *show_next( qp )
QUEUE *qp;

int *sp_used ( qp )
QUEUE *qp;

int sp_avail ( qp )
QUEUE *qp;
```

You use these routines for getting information about a queue. Show_next( ) returns a pointer to the object to be dequeued by the next call to dequeue( ), without actually removing the object from the queue. Sp_used( ) returns the number of objects

now in the queue. Sp_avail( ) returns the amount of space left in the queue. The sum of the return values of sp_used( ) and sp_avail( ) is the queue size.

The QUEUE data structure is a block of memory that includes a header describing the queue and the queue itself. The mechanism is similar to that used by alloc( ) and free( ). This structure is shown in Figure 1 (page 27).

"Start" points at the beginning of the queue proper. "Head" and "tail" are the offsets, in objects, from the start of the queue to the first and last valid objects in the queue. "Size" is the maximum number of objects that the queue can hold. "Nobj" is the number of objects currently in the queue. "Objsize" is the size of an object in bytes.

There are actually more things in the header than are, strictly speaking, necessary. For example, you can determine the start of the queue's data area by adding the header size to the queue pointer. Similarly, you can compute the number of objects in the queue from head and tail. However, these extra fields do reduce the amount of computation you need to do. If RAM is tight and ROM isn't, take them out.

Makequeue( ) (Listing One, line 27) allocates space for the queue and initializes the header. The real queue size is the number of bytes required for the queue itself (qsize × objsize) plus the size of the header.

Del_queue( ) (line 43) just calls free to return the memory used by the queue to the free list (if the queue is empty).

Objects are put into the queue with enqueue( ) (line 57). They are enqueued at the tail and dequeued from the head. The address where the object is to go is computed on line 71. Because qp->start is declared as a character pointer, pointer arithmetic is defeated (if you add 1 to a character pointer, you actually modify it by 1, not so with an integer pointer). The object is transferred into the queue, one byte at a time, on line 75, and the tail pointer is incremented on lines 77-78. If the pointer advances past

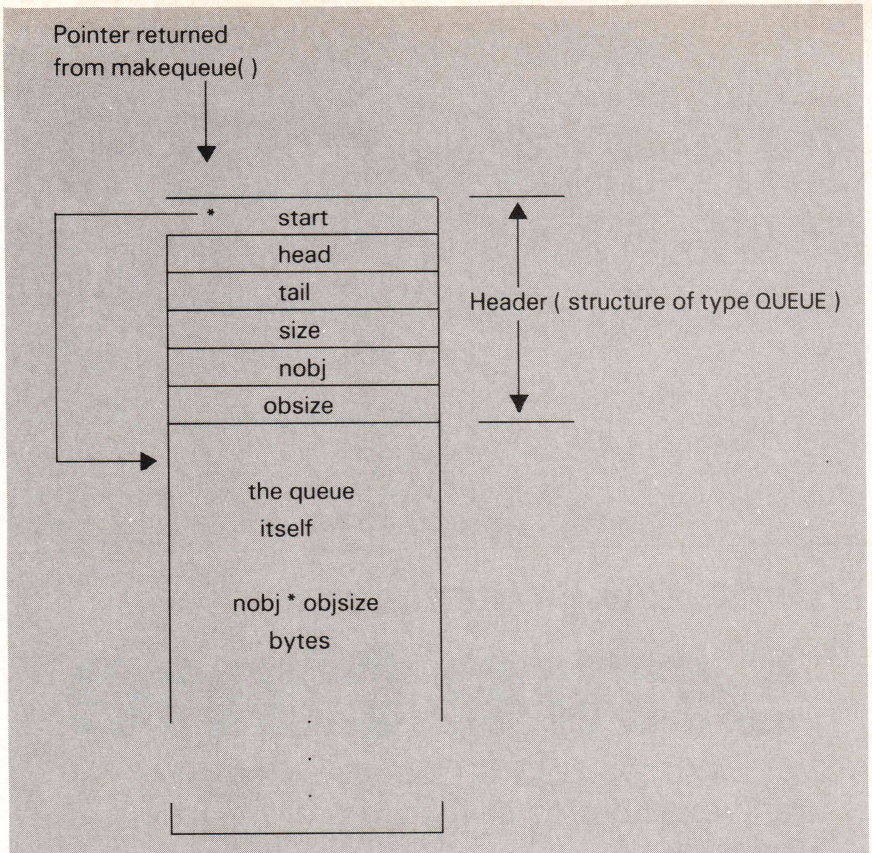


Figure 1
The queue data structure

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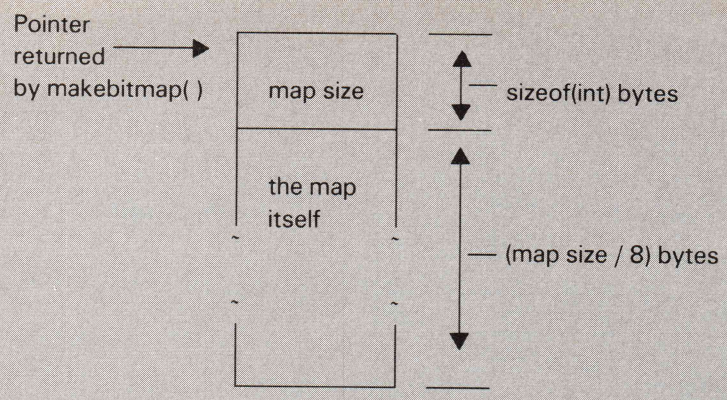

Figure 2
The bit map data structure.

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the end of the queue, it is reset to the beginning of the queue.

Head and tail are actually offsets (in elements) from the starting address of the queue. In the original versions of these routines, head and tail were pointers (which saved some computation), but the routines were harder to debug and additional computation was added in other places.

Objects are removed from the queue with dequeue( ) on line 82. It works the same way as enqueue( ) except you're now using the head rather than the tail, and you're copying in the other direction (from the queue into the object).

Bit Maps

My version of grep (*DDJ*, October 1984, #96) had several inefficiencies built into it. Some of these inefficiencies were basic to the algorithms used. As several readers pointed out, a state machine implementation would have been faster. However, changing something this fundamental would have meant throwing away most of the program.

Because the thing did work after all, I wasn't tempted to rewrite it completely. Other of the suggested improvements, however, were more reasonable. In particular, Dave Cortesi suggested using a bit map to take care of character classes; his code, which I have transformed into a set of general purpose routines, is presented in Listing Two (page 36). Listing Three (page 37) shows the various changes needed to add bit maps to grep.

Probably the biggest problem with grep.c is that I modeled the program on the version given in *Software Tools in Pascal.* I've never been able to figure out why Kernighan and Plauger did some things the way they did. Pascal does support a pointer type; why don't they ever use it?

Anyway, the problem of character classes is really a problem of set recognition. You want to define a set of characters that are legally in the character class and then to test for membership in that set. The *Software Tools* version creates a string of characters that are legal in a character class, and then searches that

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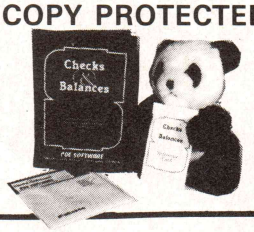

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string sequentially when testing for membership.

Because character classes are often pretty big (i.e., [A–Za–z] has 52 elements), you both waste memory and slow down the program if the character you're looking for is at the end of the list. [A–Za–z] requires 31 comparisons to find a lower-case "e," the most common letter in English.

A better solution to the set problem is a bit map in which each bit corresponds to a single ASCII character; that is, bit 0 is a NULL, bit 1 is a control-A, bit 2 is a control-B, bit 65 is an upper-case A, and so forth. So, to put a letter into the set, you set the corresponding bit in the bit map, and to see if a letter is in the set, you test the corresponding bit.

The set operation will take a little longer than it used to, but you need set a bit only once. The test operation will be much faster, and you generally test bits a lot. Memory use is more efficient too; a bit map that can hold all 128 ASCII characters needs only 16 bytes. An equivalent string would require 129. On the other hand, 16 bytes are always required, even in a small character class.

Listing Two contains three routines:

```
typedef char BITMAP;

BITMAP *makebitmap( size )
unsigned size;
```

This will make a bit map with "size" elements, requiring (size/8 + 2) bytes, and return a pointer to it. Because calloc( ) is used to do the memory allocation, the pointer returned by makebitmap( ) can be passed to free( ) to delete the map. A zero is returned if makebitmap( ) can't get enough memory.

```
setbit ( c, map, val )
unsigned c, val;
BITMAP *map;
```

This will set bit "c" of the bit map pointed to by "map" if "val" is not a zero; it will clear the bit if "val" is zero. C must be in the range 0 to size − 1, where "size" is the argument originally given to makebitmap( ). Map is a pointer returned by a previous makebitmap( ) call. A one is returned on success, and a zero if c is out of range.

```
testbit ( c, map )
unsigned c;
BITMAP *map;
```

This will test bit "c" of the bit map pointed to by "map." It returns a one if the bit is set, and a zero if it isn't or if c is out of range.

Listing Two also contains a main( ) routine for testing the three utility routines (and demonstrating how they work). A bit map containing 32 bits is made on line 66. The contents of the map are printed to the screen with the for loop on lines 74 and 75. The bit is actually set on line 80.

The subroutines are relatively straightforward. Makebitmap( ), like makequeue( ), creates a header with the bit map itself appended to it (see Figure 2, page 28). The pointer returned by makebitmap( ) points at this header, which is a single unsigned sized object (containing the number of bits in the map).

Makebitmap( ) figures the number of bytes needed on line 24 with:

```
numbytes = (size >> 3) + ((size
& 0x07) ? 1 : 0);
```

The right shift does a divide by 8, and the conditional adds 1 to the result of the divide if "size" isn't an even multiple of 8. Calloc( ) is called (on line 28) to get the memory so the bit map will be initialized to all zeroes (all bits cleared). The additional sizeof(unsigned) is for the header. A pointer to the map is returned on line 30.

Setbit( ) starts on line 32 of Listing Two. It tests for "c" out of bounds on line 39 ("map" must be cast into a pointer-to-unsigned to get the map size). We then add sizeof (unsigned) to map to skip past the map size to the map itself. The bit is set on line 43 or cleared on line 45. Testbit( ) (line 49) works just like setbit( ), the only difference being that it returns the bit's value instead of modifying it.

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Listing One

```
 1: #define DEBUG 1

 2: #ifdef DEBUG
 3: #include <stdio.h>
 4: #endif

 5: /*-------------------------------------------------------------------
 6:  *      QUEUE.C:        General purpose queue management routines:
 7:  *
 8:  *      Copyright (c) 1985, Allen I. Holub.  All rights reserved
 9:  *  This program may be copied for personal, non-profit, use only.
10:  *-------------------------------------------------------------------
11:  *
12:  *  The QUEUE data structure. No external routine needs to know anything
13:  *  about how this structure is put together. These routines need only
14:  *  remember a pointer to the queue (in a manner similar to the FILE
15:  *  pointer used by the i/o routines).
16:  */

17: typedef struct
18: {
19:         char    *start;         /* Pointer to beginning of queue        */
20:         int     head;           /* Index of current head                */
21:         int     tail;           /* Index of current tail                */
22:         int     size;           /* Max num of objects queue can hold    */
23:         int     nobj;           /* Number of objects now in the queue   */
24:         int     objsize;        /* Size of one element                  */
25: } QUEUE;

26: /*-------------------------------------------------------------------*/

27: QUEUE   *makequeue( qsize, objsize )
28: {
29:         /* Make a queue of the specified size containing objects of the
30:          * specified size. Return a pointer to the queue or 0 if there is
31:          * not enough memory to make the queue. Queues are created using
32:          * calloc(). They require sizeof(QUEUE) + (qsize * objsize) bytes.
33:          */

34:         register QUEUE  *qp;

35:         if( !(qp = (QUEUE *) malloc(sizeof(QUEUE) + (qsize * objsize)) ))
36:                 return 0;

37:         qp->start       = (char *)(qp + 1);
38:         qp->size        = qsize   ;
39:         qp->objsize     = objsize ;

40:         qp->head = qp->tail = qp->nobj = 0;

41:         return( qp );
42: }
43: del_queue( qp )
44: QUEUE   *qp;
45: {
46:         /*   Delete a queue and free the memory. The queue will NOT
47:          *   be deleted unless it is empty. Return 1 if the queue
48:          *   was deleted, 0 otherwise. If you don't care if the queue
49:          *   is actually empty, use free(qp).
50:          */

51:         if( qp->nobj )
52:                 return 0;

53:         free( qp );
54:         return 1;
55: }
56: /*-------------------------------------------------------------------*/
```

(Continued on next page)

Listing One

```
enqueue( obj, qp )
char    *obj ;
QUEUE   *qp  ;
{
        /*      Put an object into the queue. Obj is a pointer to the
         *      object qp is a pointer to a QUEUE. Return 1 on success,
         *      0 if there's no more room in the queue.
         */

        int     i;                                      /* Counter              */
        char    *bp;                                    /* points into queue    */

        if( qp->nobj  >=  qp->size )                    /* If the queue is full */
                return 0;                               /* return failure.      */

        qp->nobj++;                                     /* One more object in   */
                                                        /* the queue            */

        bp= qp->start + (qp->objsize * qp->tail); /* Get target address */
                                                        /* within the queue;    */
                                                        /* then move object     */
                                                        /* into it:             */

        for( i = qp->objsize;  --i >= 0;  *bp++ = *obj++ )
                ;

        if( ++qp->tail >= qp->size)                     /* Wrap around if we've */
                qp->tail = 0;                           /* gone off the end of  */
                                                        /* the queue.           */
        return 1;
}
dequeue( obj, qp )
char    *obj ;
QUEUE   *qp  ;
{
        /*      Get an object from the queue. Qp is a pointer to a QUEUE,
         *      The dequeued object is copied into the place pointed to by
         *      obj. Return 0 if the queue is empty and no object was
         *      dequeued, 1 otherwise.
         */

        register int    i;
        register char   *bp;

        if( qp->nobj <= 0 )
                return 0;                                       /* queue empty */

        qp->nobj-- ;

        bp = qp->start + (qp->objsize * qp->head) ;

        for( i = qp->objsize; --i >= 0; *obj++ = *bp++ )
                ;

        if( ++qp->head >= qp->size )
                qp->head = 0;

        return 1;
}

/*--------------------------------------------------------------------------*/
/*  Little access routines:                                                 */
/*      Show_next returns a pointer to the object at the head of the        */
/*      queue; sp_used returns the number of objects in the queue           */
/*      sp_avail returns the number of slots available in the queue.        */

char    *show_next (qp)
QUEUE   *qp;
{
```

(Continued on page 34)

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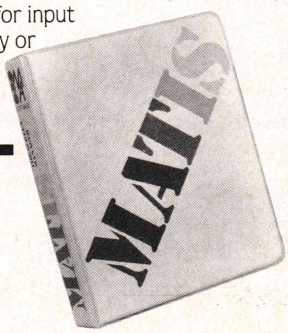

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 (Listing continued, text begins on page 26)

Listing One

```
112:        return( qp->start + (qp->head * qp->objsize)  );
113: }

114: int    sp_used    (qp)
115: QUEUE  *qp;
116: {
117:        return( qp->nobj );
118: }

119: int    sp_avail   (qp)
120: QUEUE  *qp;
121: {
122:        return( qp->size - qp->nobj );
123: }
124: #ifdef DEBUG

125: main()
126: {
127:        int     num, c, *ip;
128:        QUEUE   *qp;

129:        qp = makequeue( 4, sizeof(int) );

130:        while( 1 )
131:        {
132:                num = c = -1;

133:                ip = (int *)qp->start ;

134:                printf("\n\nqueue: %d %d %d %d\n",ip[0],ip[1],ip[2],ip[3]);
135:
136:                printf("start     =0x%x\n",     qp->start       );
137:                printf("head      =%d\n",       qp->head        );
138:                printf("tail      =%d\n",       qp->tail        );
139:                printf("size      =%d\n",       qp->size        );
140:                printf("objsize   =%d\n",       qp->objsize     );
141:                printf("nobj      =%d\n",       qp->nobj        );

142:                printf("there are %d slots left in the queue\n\n",
143:                                                    sp_avail(qp) );

144:                printf("(d/e/q) ->");
145:                while( c != 'e' && c != 'd' && c != 'q' )
146:                        c = getchar();

147:                if( c == 'e' )
148:                {
149:                        printf("enter decimal number ->");
150:                        scanf("%d", &num );
151:                        printf("enqueue(%d) returned %d\n",
152:                                                num, enqueue(&num,qp) );
153:                }
154:                else if( c == 'd' )
155:                {
156:                        printf( "dequeue returned %d, loaded %d\n",
157:                                                dequeue( &num, qp ), num );
158:                }
159:                else
160:                        break;
161:        }

162:        printf(" deleting queue, queue was %sempty\n",
163:                                        del_queue(qp) ? "" : "not " );
164: }

165: #endif
```

End Listing One

(Listing Two begins on page 36)

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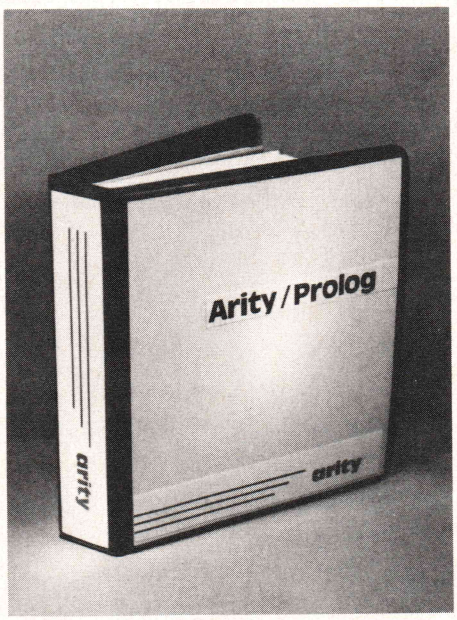

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 (Listing continued, text begins on page 26)

Listing Two

```
 1: /*      BITMAP.C        makebitmap, setbit, testbit: bit map manipulation
 2:  *                      routines.
 3:  *
 4:  *      Copyright (c) Allen I. Holub, all rights reserved. This program
 5:  *      be copied for personal, non-profit use only.
 6:  */

 7: #ifdef DEBUG
 8: #include <stdio.h>
 9: #endif

10: typedef char BITMAP;

11: /*--------------------------------------------------------------------------*/

12: BITMAP    *makebitmap( size )
13: unsigned  size;
14: {
15:         /*      Make a bit map with "size" bits. The first entry in
16:          *      the map is an  unsigned int representing the maximum
17:          *      bit. The map itself is concatenated to this integer.
18:          *      Return a pointer to the map on success, 0 if there's
19:          *      not enough memory.
20:          */
21:
22:         unsigned *map, numbytes;
23:
24:         numbytes = (size >> 3) + ((size & 0x07) ? 1 : 0 ) ;

25: #ifdef DEBUG
26:         printf("Making a %d bit map (%d bytes required)\n", size, numbytes);
27: #endif

28:         if( map = (unsigned *) calloc( numbytes + sizeof(unsigned) ,1 ) )
29:                 *map = size;

30:         return (BITMAP *) map;
31: }
32: setbit( c, map, val )
33: unsigned  c, val;
34: char      *map;
35: {
36:         /*   Set bit c in the map to val.
37:          *   If c > map size, 0 is returned, else 1 is returned.
38:          */

39:         if(  c >= *(unsigned *)map )            /* if c >= map size */
40:                 return 0;

41:         map += sizeof(unsigned);                /* Skip past size   */

42:         if( val )
43:                 map[c >> 3]  |=    1 << (c & 0x07) ;
44:         else
45:                 map[c >> 3]  &=  ~(1 << (c & 0x07)) ;

46:         return( 1 );
47: }


48: /* ------------------------------------------------------------------- */


49: testbit( c, map )
50: unsigned c;
51: char     *map;
52: {
53:         /*   Return 1 if the bit corresponding to c in map is set.
54:          *   0 if it is not.
```

```
55:          */

56:         if( c >= *(unsigned *)map )
57:                 return 0;

58:         map += sizeof(unsigned);

59:         return(  map[ c >> 3 ]  &  (1 << (c & 0x07)) );
60: }
61: #ifdef DEBUG

62: main()
63: {
64:         int     bitnum, set, i, *map;

65:         printf("Making a 32 bit wide bit map\n");

66:         if( !(map = makebitmap( 32 )) )
67:                 printf("Can't make map\n");

68:         while( 1 )
69:         {
70:                 /* Print the bit map. Try to print past the end of the
71:                  * map to make sure overflow detection works (bit 32 should
72:                  * come back as a 0).
73:                  */

74:                 for( i = 0; i <= 32 ; i++ )
75:                         putchar( testbit( i, map ) ? 'X' : '.' );

76:                 printf("\n\nBit number :");
77:                 scanf("%d", &bitnum );
78:                 printf("\nl to set, 0 to clear: ");
79:                 scanf("%d", &set );

80:                 if( ! setbit(bitnum, map, set) )
81:                         printf("Bit out of range\n");
82:         }
83: }

84: #endif
```

End Listing Two

Listing Three

```
 1: /*-------------------------------------------------------------------+
 2:  * GREP:  Changes needed to add bit maps to character classes:       |
 3:  *-------------------------------------------------------------------+
 4:  */

 5: typedef struct token                                 /* In tools.h */
 6: {
 7:         char            tok;
 8:         char            lchar;
 9:         char            *bitmap;
10:         struct token    *next;
11: }TOKEN;

12: /*-------------------------------------------------------------------*/

13: TOKEN   *makepat(arg, delim)                         /* In tools.c   */
14: char    *arg;
15: int     delim;
16: {
17:                                 *
18:                                 *
19:                                 *
20:                 case CCL:

21:                         if (*(arg+1) == NEGATE)
22:                         {
23:                                 ntok->tok = NCCL;
24:                                 arg += 2;
25:                         }
```

(Continued on next page)

Listing Three

```
26:                             else
27:                             {
28:                                     ntok->tok = CCL;
29:                                     arg++;
30:                             }

31:                             if( ntok->bitmap = makebitmap(128) )
32:                                     arg = dodash(CCLEND, arg, ntok->bitmap );
33:                             else
34:                             {
35:                                     fprintf(stderr,"Not enough memory for pat\n");
36:                                     error = 1;
37:                             }
38:                             break;

39:                                     *
40:                                     *
41:                                     *
42: }
43: char    *dodash( delim, src, map )              /* In tools.c   */
44: int     delim;
45: char    *src, *map;
46: {
47:         register int    first, last;
48:         char            *start;

49:         start = src;

50:         while( *src  &&  *src != delim )
51:         {
52:                 if( *src != '-')
53:                         setbit( esc( &src ), map, 1 );

54:                 else if( src == start  ||  *(src+1) == delim )
55:                         setbit( '-', map, 1 );
56:                 else
57:                 {
58:                         src++;

59:                         if( *src < *(src - 2) )
60:                         {
61:                                 first = *src;
62:                                 last  = *(src-2);
63:                         }
64:                         else
65:                         {
66:                                 first = *(src - 2);
67:                                 last  = *src;
68:                         }

69:                         while( ++first <= last )
70:                                 setbit( first, map, 1);

71:                         src++;
72:                 }
73:         }

74:         return( src );
75: }
76: int     omatch (linp, pat, boln)                /* In tools.c   */
77: char    **linp, *boln;
78: TOKEN   *pat;
79: {
80:                                 *
81:                                 *
82:                                 *

83:                 case CCL:
84:                         if( testbit( **linp, pat->bitmap ) )
```

(Continued on page 40)

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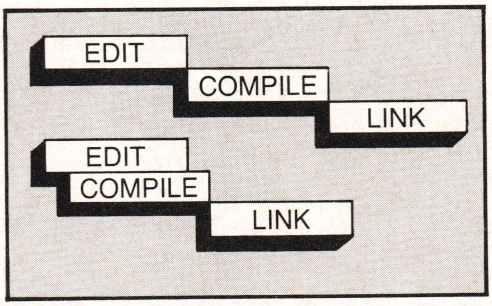

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 (Listing continued, text begins on page 26)

Listing Three

```
 85:                                    advance = 1;
 86:                            break;

 87:                    case NCCL:
 88:                            if( !testbit( **linp, pat->bitmap) )
 89:                                    advance = 1;
 90:                            break;

 91:                                    *
 92:                                    *
 93:                                    *
 94: }

 95: /*--------------------------------------------------------------------------*/

 96: pr_tok( head )                                        /* In tools.c   */
 97: TOKEN   *head;
 98: {                                  *
 99:                                    *
100:                                    *

101:                    if (head->tok == CCL || head->tok == NCCL)
102:                    {
103:                            printf("string (at 0x%x) =<", head->bitmap );

104:                            for( i = 0; i < 0x7f ; i++)
105:                                    if( testbit(i, head->bitmap) )
106:                                            putchar(i);

107:                            printf(">, ");
108:                    }

109:                                    *
110:                                    *
111:                                    *
112: }

113: unmakepat(head)                                       /* In tools.c   */
114: TOKEN   *head;
115: {
116:            register TOKEN  *old_head;

117:            while (head)
118:            {
119:                    switch (head->tok)
120:                    {
121:                    case CCL:
122:                    case NCCL:
123:                            free(head->bitmap);
124:                            /* no break, fall through to default */

125:                    default:
126:                            old_head = head;
127:                            head = head->next;
128:                            free(old_head);
129:                            break;
130:                    }
131:            }
132: }
```

End Listings

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UniPress Software

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by Axel Schreiner

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/lib/cpp

This column deals with uses and abuses of the C preprocessor. It demonstrates some techniques that can save a lot of work and even more errors. The discussion applies to programming in C in general and makes only very elementary assumptions:

> C programs are run through a preprocessor *before* they are handed to the actual compiler. The preprocessor performs (parameterized) text substitution (#define), inserts header files (#include), and can exclude parts of the source from compilation (#if).

Because the preprocessor is independent of the actual compiler—and does not know C at all—one can use it in particular to extend the C language. Only taste limits one's imagination here . . . .

Excluding Text

Every programmer writes occasional comments. Sometimes we comment to exclude program parts from a compilation. Because in Standard C comments may not be nested, there is considerable temptation not to comment such excluded program parts anymore.

The following technique for text exclusion is much more appropriate:

```
#ifdef not_defined
   crash_the_system(NOW);
   /* this definitely goes wrong */
#endif not_defined
```

Of course, the name not_defined should really not be defined.

Vector Dimensions

In principle, one can determine the size of a vector by using the sizeof operator. However, sizeof yields the size in bytes, not in elements. The following macro determines the number of elements in an arbitrary vector:

```
#define DIM(x) (sizeof (x) / sizeof ((x)[0]))
```

sizeof does not really need parentheses, if it is used to determine the size of an object and not of a data type. One should, however, enclose macro parameters in parentheses. Then things work out for a vector with more than one dimension, too:

```
main( )
{
      struct { int a; char b; } v[10] [20] [30];
      printf("%d %d %d\n", DIM(v), DIM(v[1]),
            DIM(v[1] [2]));
}
```

The program produces the values 10, 20, and 30.

Parentheses should not be necessary in this use of sizeof because a vector subscript should have precedence over sizeof. However, my copy of the Mark Williams CP/M-86 C compiler does not seem to know this.

We can carry these ideas somewhat further. The last element of a vector is

```
#define LAST(x) ((x)[DIM(x)-1])
```

and the customary for loop is, for example:

```
#define END(x) ((x) + DIM(x)-1)

int vector[10], * vp;
   . . .
   for (vp = vector; vp <= END(vector); ++ vp)
      . . .
```

The compiler evaluates sizeof during its evaluation of constant expressions. This circumstance can be used to determine the length of constant strings in an efficient and flexible fashion:

```
#define STRLEN(s) (sizeof (s) - 1)

char buf[STRLEN("model") + 1];
   . . .
   strcpy(buf, "model");
```

There is the danger, however, that STRLEN is used for other objects (i.e., non-strings) by mistaking it for strlen.

Trace

It is well known that a *macro call* is not recognized in a

constant string. Less well known, but more useful perhaps, is that a *macro parameter* is recognized and replaced within the replacement text of a macro definition. Rather than

```
printf("variable = %d\n", variable);
printf("formula = %f\n", formula);
```

we write

```
#define SHOW(val,fmt) fprintf(stderr,\
        "SHOW: val = fmt\n", val)

        SHOW(variable, %d);
        SHOW(formula, %f);
```

The latter is easier to use and conveys more information because val is replaced in the format by the entire macro argument.

A bit of caution is required: if the % operator is used within val, there will be problems with the format. This can be corrected as follows:

```
#define SHOW(val, fmt)  fprintf(stderr, "%s\
   = fmt\n", "val", val)
```

A macro can be defined without a replacement text. Uses of SHOW thus can be eliminated easily from the compiled program altogether. Alternatively, we can specify a condition:

```
#ifdef   DEBUG
         char debugflag;
#        define SHOW(val,fmt) (debugflag &&\
               fprintf( . . . ))
#else    ! DEBUG
#        define SHOW(val,fmt) /* null */
#endif   DEBUG
```

In this example, SHOW is always used as a statement and not as an expression. Using && rather than if has two advantages: we do not *have* to use SHOW as a statement, and use of SHOW does not invite an unintentional else. debugflag, by the way, should be used as a bit vector, e.g.:

```
#define SHOW(level, val, fmt) (debugflag &\
   1<<level && fprintf( . . . ))
```

Now we can maintain different sets of trace information at levels 0 through 7.

Global Variables

Do you like modular programs with lots of sources, makefile, a central header file, and the (feeble) hope that all global declarations really match? Do you like to lint, too? The following technique simplifies maintaining global variables. The central header file contains about the following:

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```
#ifndef   GLOBAL
#         define GLOBAL extern
#endif    GLOBAL

GLOBAL  int   global_variable;
```

If GLOBAL is not defined, a variable declared GLOBAL is declared extern.

Within exactly *one* of the source files that include the header file, we have to take care that the variables that were declared extern elsewhere are really defined. In the main source file, we therefore write:

```
#define GLOBAL /* to define global variables */
#include "definitions.h"
```

One can even initialize global variables in this context *without* resorting to the −m flag instructing the loader ld to accept multiple definitions:

```
#ifdef    GLOBAL
#         define    INIT(x) = x
#else     ! GLOBAL
#         define    GLOBAL extern
#         define    INIT(x)
#endif    GLOBAL

GLOBAL  int variable INIT(10);
```

This technique is not very practical for aggregates. The following variant is easier to use:

```
#ifdef    GLOBAL
#         define    INIT(x) =x
#         define    GINIT
#else     ! GLOBAL
#         define    GLOBAL extern
#         define    INIT(x)   ;
#         undef     GINIT
#endif    GLOBAL

GLOBAL  struct { int a; char b; } variable INIT( )
#ifdef    GINIT
                    { 10, 'b' };
#endif    GINIT
```

This method requires that the C preprocessor permit a macro call with an empty argument list and that the C compiler not complain about superfluous semicolons between global declarations. This method is admittedly no longer very elegant, but it has the significant advantage that the text of central definitions exists only once in all cases.

/bin/lex

Now you see it . . .

lex programs have lots in common with fashions: the effect is not always what the pattern promises. If a function generated by lex is used as a front end for a parser generated by yacc, it is sometimes very hard to decide where to place the blame for a bug: is there a bug in the grammar presented to yacc, or are the patterns that were processed by lex at fault?

The following technique[1] permits the construction of a source file for lex that is conditionalized so that a debugging version can be compiled at any time without any changes to the source. To test the results of lex, all inputs that the parser is to receive later are first presented to the debugging version. This version of the front end then prints a mnemonic version of the values that the parser would receive:

```
%{
#ifdef  TRACE

#       include "assert.h"

        main( )
        {
                char *cp;
                assert(sizeof(int) >=
                   sizeof(char *));
                while (cp = (char *) yylex( ))
                   printf("%-.10s is \"%s\"\n",
                      cp, yytext);
        }

#       define token(x)  (int) "x"

#else   ! TRACE

#       include "y.tab.h"
#       define token(x)  x

#endif  TRACE
%}
```

Normally, TRACE is undefined, and the tokens (i.e., the values that are to be returned to the parser) are defined in the file y.tab.h generated by yacc as:

```
#define NAME     257
        . . .
```

These defined names are used directly in the source presented to lex and are returned as a result of the function yylex( ).

If TRACE is defined, y.tab.h need not yet exist. In this case (i.e., in the debugging version), we want to return a string as a result of yylex( ) that is then printed by the main( ) program included here.[2] Analyzing the debugging output is most easily accomplished if the output uses exactly those words that later will appear in y.tab.h—i.e., that are a result of %token statements in the source presented to yacc.

We are using the fact that macro parameters are replaced within strings in the replacement text of a macro. token(x) returns either x itself (to be passed on to yacc) or

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a string "x" for the purposes of TRACE.

The remainder of the lex program is now quite obvious:

```
%%

[0-9]+                  return token(NUMBER);
[a-z_A-Z][a-z_A-Z0-9]*  return word( );
[ \t\n]+                ;
.                       return token(yytext[0]);

%%

struct reserved { char * text; int yylex; } reserved[ ] = {
    { "begin", token(BEGIN) },
    { "end", token(END) },
    (char *) 0 };
int word( )
{

    struct reserved *rp;
    for (rp = reserved; rp->text; ++ rp)
        if (strcmp(yytext, rp->text) == 0)
            return rp->yylex;
    return token (NAME);
}
```

Yes, there should have been a binary chopped search, but we are dealing only with the principles.

/usr/src/main.c

Argument Standards

Command arguments are always good for surprises. Sometimes several options may be combined into one argument; sometimes each option must be a separate argument; sometimes a parameter value follows as part of the argument; sometimes it does not; sometimes all of the above; sometimes some of the above . . . .

If one consults the sources of certain Unix utilities, one learns to appreciate the flexibility of C (or the infinite patience of the C compiler). Everybody does his or her own thing, and most do it differently in every program! However, it would be so simple to develop a standard as in Listing One, page 48).

At show( ), argc contains the number of arguments that have not yet been processed, and *argv is the first one of these. This argument can be a single – character; in some ancient (cat) and almost new (tar) utilities, this indicates that standard input or output is to be used in place of a file argument.

Flags can be combined at will. If an option requires a value, it can follow immediately or it can be an argument of its own.

Following a standard proposed in the "USENIX login," an option – – serves to terminate processing of the option list. Apart from that, options must start with – and must precede other arguments. These rules, however, still do not cover all possibilities of pr.

The skeleton above is useful but anatomically somewhat terrifying. The following incarnation is perhaps more attractive:

```
#include <stdio.h>
#include "main.h"

#define show(x) printf("x = %d\n", x)
#define USAGE fputs("cmd [-f] [-v   #]\n",\
    stderr ), exit(1)

MAIN
{
        int f = 0, v = 0;

        OPT
                ARG 'f':
                        ++ f;
                ARG 'v':
                        PARM
                        v = atoi(*argv);
                        NEXTOPT
                OTHER
                        USAGE;
        ENDOPT
    show(f), show(v), show(argc);
    if (argc)
        puts(*argv);
}
```

The trick, of course, is concealed in the header file main.h: here the macros OPT, ARG, PARM, NEXTOPT, OTHER, and ENDOPT must be defined using exactly those texts that were given explicitly in the previous example, as in Listing Two, (page 50).

The definitions are not exactly beautiful, especially if they need to be compacted so that the C preprocessor accepts the lengthy replacement texts, but they need to be developed only once to make the argument standard available for all applications. An application then is almost self-documenting:

MAIN
is the function header of the main program.

OPT
starts the loop during which the options are processed.

ENDOPT
completes this loop.

ARG
within the loop starts the processing of one option; the name of the option (a single character) enclosed in single quotes and a colon must follow.

PARM
follows the option specification if the option has a value parameter; the parameter itself is then available as *argv.

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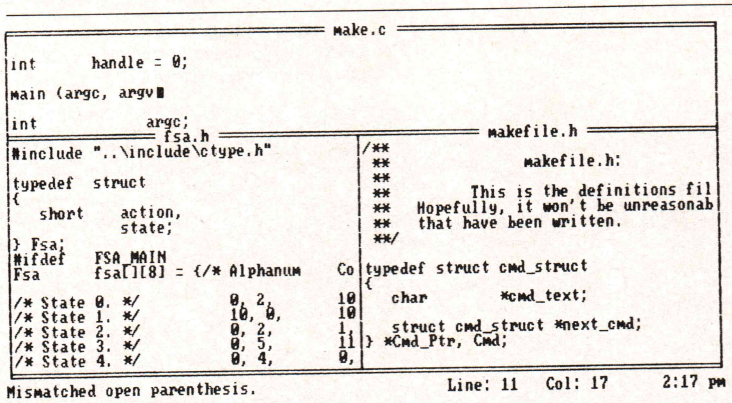

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NEXTOPT
is used once such a parameter has been processed to advance to the next command argument.

OTHER
must follow all options; following this, one specifies what should be done if an option could not be recognized. NEXTOPT may be specified in this case, too. The unknown option itself is **argv.

After the OPT ENDOPT loop, argc contains the number of command arguments that have not yet been processed, and *argv is the first such argument. Arbitrarily many (different) options ARG can be specified. pr would be implemented approximately as follows:

```
MAIN
{
    do
    {
        OPT
            ARG 'h':
                PARM
                header = *argv;
                NEXTOPT
            ARG 'w':
                PARM
                width = atoi(*argv);
                NEXTOPT
            ARG 'l':
                PARM
                length = atoi(*argv);
                NEXTOPT
            ARG 't':
                tflag = 1;
            ARG 's':
                PARM
                delimiter = **argv;
                ++*argv;
                NEXTOPT
            ARG 'm':
                mflag = 1;
            OTHER
                if (isdigit(**argv))
                    columns = atoi(*argv),
                        NEXTOPT
                else
                    USAGE, exit(1);
        ENDOPT

        if (argc)
        {
            if (**argv == '+')
            {
                PARM
                first_page = atoi(*argv);
                continue;
            }

            dopr(*argv);
        }
        else
            dopr("-");
    } while (argc > 1);
}
```

There is a blemish: - columns must be secified as a single argument (because - alone refers to standard input).

Notes

[1] This technique was developed for the book *Introduction to Compiler Construction* by A. T. Schreiner and H. G. Friedman, Jr., Prentice-Hall, 1985.

[2] The technique requires that a pointer to a character string be returned in place of an int value. This is not possible across all implementations of C; e.g., it is probably not allowed on the 7300 systems. We guard against a portability problem by using assert( ). **DDJ**

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```
#include <stdio.h>

#define show(x) printf("x = %d\n", x)
#define USAGE fputs("cmd [-f] [-v  #]\n", stderr), exit(1)

main(argc, argv)
int argc;
char **argv;
{
    int f = 0, v = 0;

    while (--argc > 0 && **++argv == '-')
    {
        switch (*++*argv)
        {
            case 0:                                    /* - */
```

Listing One

(Continued on page 50)

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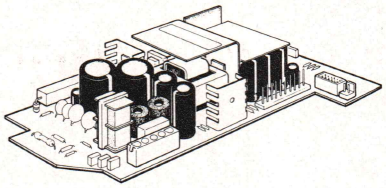

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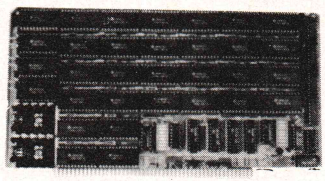

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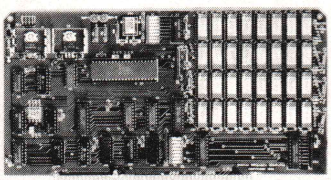

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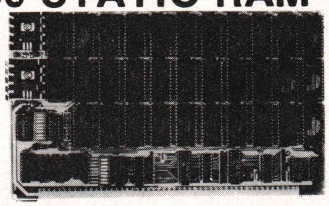

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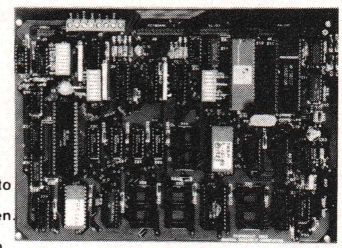

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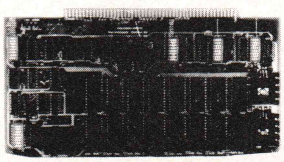

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(Continued from page 48)

```
                --*argv;
                break;
            case '-':
                if (! (*argv) [1])                          /* -- */
                {
                    ++ argv, -- argc;
                    break;
                }
            default:
                do
                {
                    switch (**argv)
                    {
                        case 'f':                           /* -f */
                            ++ f;
                            continue;
                        case 'v':
                            if (*++*argv)
                                ;                           /* -v# */
                            else if (-- argc > 0)
                                ++argv;                     /* -v # */
                            else
                                break;
                            v = atoi(*argv);
                            *argv += strlen(*argv) -1;
                            continue;
                    }
                    USAGE;
                } while (*++*argv);
                continue;
            }
            break;
        }
        show(f), show(v), show(argc);
        if (argc)
            puts(*argv);
    }
```

Listing One

```
#define MAIN    main(argc, argv)                    \
                int argc;                           \
                char ** argv;

#define OPT     while (-- argc > 0 && \ **++argv    \
                    == '-')                         \
                {                                   \
                    switch (*++*argv)               \
                    {                               \
                        case 0:                     \
                            --*argv;                \
                            break;                  \
                        case '-':                   \
                            if (! (*argv) [1] )     \
                            {                       \
                                ++ argv, -- argc;\
                                break;              \
                            }                       \
                        default:                    \
                            do                      \
                            {                       \
                                                    \
                                switch (**argv)     \
                                {                   \

#define ARG     continue;                           \
        case
#define OTHER   continue;                           \
                }
#define ENDOPT  } while(*++*argv);                  \
                continue;                           \
            }                                       \
            break;                                  \
        }

#define PARM    if (*++*argv)                       \
                    ;                               \
                else if (-- argc > 0 )              \
                    ++argv;                         \
                else                                \
                    break;

#define NEXTOPT *argv += strlen(*argv)-1;
```

Listing Two

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Information Age Issues

by Dean Gengle

The real issues in telecommunications dwarf questions about protocol and baud rate. This is an essay on responsibility.

My first experiences with a modem, a microcomputer, a television set, and a telephone linked together—with me in the loop—were much like my first discoveries regarding the true significance of portions of my own anatomy. These experiences combined the joys of intellectual insight, emotional pleasure, physical involvement, and all the wonder we associate with the notion of "surprise."

On-Line Life

I conducted my early experiments in on-line living with no misgivings at all. I was able to consider only the positive possibilities contained in this new technical capability. Modemocracy! Distributed networks! Grass roots anticipatory guidance systems! It all seemed within reach if only everyone would use these tools. The sheer weight of the new experiences themselves bolstered my initial faith that folks would come to use these tools in the "right" way.

I remember distinctly the moment when the inevitable mental disappointment occurred and reality set in—about six weeks after my first modem fix (ca 1980). I was logged on a local bulletin board system (BBS). I had just finished entering a private reply to a particular message; it was meant to go directly to another user of the system. On my screen flashed "Hi." Weird response. Commands issued to the remote computer no longer worked. Instead, the system operator (sysop) had taken over and was typing messages at me directly.

"I've been watching your session," he wrote, in the most casual and matter-of-fact manner. "Thought I'd say hello." In that instant, the scales fell from my eyes, so to speak. My illusion of privacy was shattered, an illusion maintained without my awareness by a number of supporting factors. I was working out of my own apartment, a bedroom with a spare corner space, in fact. What could be more personal or private? Also, I've never had any reason to think that my phone was tapped, so I've always regarded phone conversations as "private" My modem is hooked to the phone, ergo . . . . Besides, the remote computer system itself reinforced my illusion by allowing "private" messages between individuals and by requiring a password to read "mail."

All along, that sysop might have been looking over my shoulder, reading what I typed, aware of when and how I used the system. The implications of that made me decidedly uncomfortable. Since then, I have become aware of other sysops who've turned their computers into dictatorchips. They not only eavesdrop at will but run their systems with the firm style of a Khomeni. (Confess or I pull out your passwords!) Large systems and small are run this way. The truly astounding thing is that some people seem to *like* that sort of relationship. Still, I hope, there numbers are not great. Not here. Not in the U.S. of A.

Dean Gengle, 1150 Bryant St., San Francisco, CA 94103 (415) 861-8733.

Info Liberties

The net result of this is that I've been led, willy-nilly, into what has become an ongoing interest in civil liberties and technology. I have found that specific design decisions of an apparently "purely technical" nature can and often do have an effect on what we consider to be our personal liberties and freedoms. Conversely, social values can affect what and how new technology is designed.

The controversies that arise from this interplay taken together can be called *information age issues*. They all focus on the handling of information: who generates it; who can store it; who can ship it around; who can have it; who can control it; who can copy it and who cannot; what is and is not legitimate information in a given instance—hence, "information age."

It is becoming increasingly difficult to draw a firm line between the idea of telecommunications and the idea of computing. Some commentators have coined terms such as *telecomputing* and *compunications* to make this point. (I will spare the reader any further use of these, however.) Distinctions between media are blurring fast. All kinds of information now can take digital form to be zapped across various channels, whether phone lines, fiber optic cables, cellular networks, or satellite transponders.

For the time being, I find it useful to think of *telecommunications* as any form of electronic transmission requiring temporary or permanent physical connections.

The examples that follow are representative of the dilemmas we already confront. I can only hint at telecommunications-related conundrums (or nightmares) we may have to face in the months and years directly ahead.

Freedom from Eavesdropping

The kind of surveillance conducted by the sysop I described earlier is not the only kind that new technologies have made possible. Signals of all kinds are now being intercepted on a widespread scale. On the governmental level, spy agencies around the world engage in SIGINT (signal intelligence) work:

- Radio and television broadcasts, voice and data phone calls, satellite channels, international telex and TWX and Western Union transmissions, and amateur radio broadcasts are all monitored. The superpowers conduct the most sophisticated monitoring, as one would expect, but the technology of signal interception is getting cheaper every day.
- Telephone company officials, FBI agents, and credit card companies go on "fishing expeditions" in local microcomputer-based message systems. Ostensibly, they are looking for exchanges of "illegal" data, such as computer access numbers and passwords, phone credit card numbers, and so on. Who knows what other subversive material these official intruders might turn up?
- Although laws surrounding the tapping of voice telephone calls are stringent when they deal with what may and may not be used as trial evidence or when warrants are required and when they are not, no such laws cover eavesdropping on private data transmissions. With large computers doing the listening and sifting, it is a simple matter to monitor thousands of data phone calls.

Meanwhile, in the commercial sector, cellular mobile telephone systems are being marketed heavily in major metropolitan areas across the country. However, cellular channels can be monitored with easily built "scanners" similar to those used to monitor police and CB channels.

Thus, as the cellular service suppliers themselves admit, those top level business calls we make from the middle of traffic jams may not be private. The service suppliers downplay this aspect of cellular mobile telecommunications. After all, there are 666 assigned channels, and the channel assignment for a particular call *does* shift as the user moves from cell to cell. But even if it isn't technically feasible to build a scanner capable of following a particular call, you probably shouldn't conduct sensitive business by cellular phone anyway, according to the suppliers. So much for productivity in traffic jams.

A few companies already are planning to connect modems and micros to cellular telephones. Get your electronic mail from anywhere, anytime. There is no reason to think this evolution will stop until someone makes a device that is a cellular phone, voice and data terminal, and microcomputer, all in one portable package. The temptation to use such a device will grow right along with the temptation to listen in.

"Freedom from eavesdropping" is more apt as a rallying cry than "right to privacy" because certain forms of eavesdropping do not intrude directly on our privacy. For example, others can gather and analyze information about your phone calls even if they do not monitor directly the content of the calls themselves. Within many corporate settings, this already is being done.

Information about whom you call, when you call, the duration of the call, and the frequency of calls to particular numbers all can be collected without your knowledge. To some extent, the same laws covering voice phone tapping hedge the ability of police and government to use such information. However, no such laws cover intraorganizational phone monitoring. Monitoring systems are marketed under the rubric of "phone management" and "automatic call distribution and reporting systems."

One company advertisement for this kind of system is a touch Orwellian in its copy: "To check out your staff's performance, you can either walk around the office. Or get one of [our] automatic call distribution systems. They actually print out detailed reports on every single person's hourly performance: Who needs a raise. And who needs improvement."

Freedom to Play vs. the Drive for Security

Given the complexity of our society, we are far more likely to lose our valued freedoms bit by bit than all at once. Freedoms also are more likely to erode faster as a result of nongovernmental institutional decisions.

As technicians, software designers, hardware designers, and computer users, we have as much to lose through the misapplication of technology as anyone else. We are

also, perhaps, in a better position to prevent misapplications than anyone else.

There is much attention paid these days to the ubiquitous "hacker," whoever that may be. The hacker is linked in the public mind with computer crime. This was not always so, although the reasons for this association are many. Yet, whether one thinks of oneself as a hacker or not, the solutions to the problems of computer crime don't seem to lie in the direction of hiring more consultants. Nor does it make much sense to try to rehabilitate the image of the hacker by making him or her into some sort of cultural hero(ine).

Along with the hacker image, the public is being sold a bill of goods concerning computer crime. Such crime, by and large, is portrayed as something an individual does to an organization, using a microcomputer. The public sees computer crime as "breaking and entering" large systems, whether to take money gains, information gains, or both. But other kinds of computer abuse are not labelled as "crimes" or "criminal" and, for the most part, are not even mentioned in the mass media that shape public consciousness on such matters. The daily papers do not discuss the idea that data eavesdropping by government, corporate, or even private individuals on private citizens may also be criminal. Nor does the idea that the IRS or NSA may be tapping the communications and computers of private individuals receive much consideration. The laws that are discussed and passed are laws aimed at individual abuse, not large-scale institutionalized abuse.

Often, the quest for security tramples our rights to privacy and individuality. In the drive for absolute security in an absolutely efficient society, we may lose the one thing we need in order to survive and prosper in the global information economy: the freedom to play and its attendant creativity.

No matter what the end product, creative (and therefore innovative) ideas are nurtured in an atmosphere of play. The balance between control and freedom must be struck in actual design decisions we make from day to day. The impact of one implementation vs. another on our overall freedoms must be part of design decisions.

High on the list of needed design developments in an era of mass telecommunications is some sort of public key encryption and signature system that is mass-producible and inexpensive and secure from any kind of eavesdropping. The jury still seems to be out on whether or not the DES (Data Encryption Standard) is really secure from megacomputer cracking power. This is an area where some effective designs could improve all our on-line lives, but it is only one example.

The Future of Paranoia

Future problems in telecommunications may make today's problems seem relatively trivial by comparison. As expert systems take up residence in our telecommunications networks, designers will have to become even more concerned with individual freedoms—constitutional and civil liberties—than they are now.

For example, it is feasible to expect that various information suppliers, data banks, and mass information utilities will be able to learn about users in sophisticated ways: what your interests are, what items to call to your attention based on your past use of the system, what you read and what you ignore, what kind of equipment you have, your age, marital status, and economic position, and so forth.

It would be nice to interact with a system that appears custom tailored to your needs and use. However, it is not a big leap to go from information about how you've interacted with, say, a "smart Source" or "intelligent CompuServe" to a psychological and/or political profile. This sort of information analysis is good not only for marketers who want to sell you things but for politicians, power junkies, and competitors who want to know all they can about you for reasons of their own.

Approaches to Action

People directly involved in making technical decisions for design or implementation are, as I said earlier, in a good position to act as *ad hoc* advisers to the general public, the media, and lawmakers at local, state, and federal levels. Technical people, along with artists, can act as "antennae for the race" in matters of sociotechnical importance. If you are involved in the early design stages of an expert software system to correlate IRS data with SSI information, to take one hypothetical example, you'll know before the rest of us do how that system can be abused and put to uses never intended in the first place.

We've all heard that the price of liberty is eternal vigilance. But just how one remains vigilant in an age of rapid technological change is not so obvious. Responses to upcoming issues can take a variety of forms, whether individual, institutional, or governmental. It has become an article of faith for me, having studied and worked in this arena for several years, that individual responses are preferable to institutional ones and institutional ones preferable to governmental intervention. However, we will need all these approaches.

Individual Responses

Individual technicians and designers play a large role in the creation of technical standards and on standards bodies. In telecommunications, for instance, global standards for videotext, viewdata, and teletext systems have yet to emerge. Standards can affect the kinds of competition possible and hence the marketplace. It is not unheard of for standards to be adopted, not on their merit, but for overtly political reasons.

More individual participation in the creation of new standards, therefore, is one way in which technicians and designers can respond.

Educating our friends and neighbors who are not technically inclined is another way to respond to the changes raining down. Explicit information on the connections between technical possibilities and quality of life is needed on a wider scale than ever before.

Organizational Responses

When biotechnology began to hint that doctors and biological technicians could have a profound influence on the

direction and quality of human life, medical schools and other establishments of higher learning began to teach formal courses in medical and biological ethics.

Today, when computer technology has had—is having—an equally profound effect on our quality of life, almost none of the establishments responsible for technical education are providing courses equivalent to those taken by medical students. A few formal studies of "technical ethics" and "information age ethics" are being conducted, but these are one-shot projects, not long-term educational efforts. Therefore, one possible institutional response to information age issues is to provide courses that combine the study of ethics and morals with the study of information science and the future of telecommunications.

Legal Responses

It's important that, in the discussion of what is and is not "computer crime," we not let high-priced "security consultants" or politicians with their own axes to grind make our laws for us.

It is especially important that we not let the rare occurence of a "hacker break-in" distract us from the larger and potentially more serious issues at hand. The Privacy Act and the Freedom of Information Act, for example, have suffered consistent erosion over the last 10 years by administrative decree and bureaucratic red tape.

As more government information is put on line and made accessible by computer, no one is talking about our rights to access information that is *not* private and that was collected legally at taxpayers' expense. Census data and Library of Congress information come to mind. (You can get census data now, certainly, if you have certain kinds of computers and are willing to pay a lot for it.) The government is probably the largest single source of useful information in this country. Making that information available to the micro-using public is an issue worthy of Congressional attention.

Last Words

I don't have any. I am willing to bet that some of the people who read this piece are engaged, even now, in debates on design that will come to wider attention only after a particular piece of outrageous hardware or software has been manufactured and distributed. Even now, you probably can think of a dozen or so issues I've not been able to cover here because of my own ignorance or lack of space.

In this business of telecommunications, there are no last words. Therefore, for all our sakes, I urge you to add yours to the heap.

Dean Gengle is a software documentation specialist and consultant at CommuniTree Group in San Francisco. He is the author of The Netweaver's Sourcebook. **DDJ**

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Modems: 2400 Bit/Sec and Beyond

by Dale Walsh

Electronic data communication, in its simplest form, employs binary signaling common in logic and microprocessor circuits. A "high" signal is one, and a "low" signal is zero. We have seen dramatic increases in how fast electronic logic devices can switch binary logic levels. Each new computer, it seems, is several times faster than its predecessor. This is achieved primarily by reducing large-scale integration (LSI) devices in size to increase device speeds. We in the communications field would say "they kept binary signaling but increased signal bandwidth."

The one sure thing about the new 2400-baud modems is that we'll find them intolerably slow before the next thing comes along.

We usually associate bandwidth with frequency limits: our hearing bandwidth is from 20 Hz to 12,000 Hz, for example. But bandwidth also limits how fast things can move. Run in water and you appreciate that water is a narrow bandwidth medium, at least for physical movement.

In their efforts to keep pace with the demand for higher speeds, modem designers immediately collided with a limited resource: by and large, signal bandwidth, set by the telephone channel, is fixed. Two approaches will increase speed: (1) use more of the available bandwidth, and (2) construct densely packed signaling alphabets so that each signaling interval uniquely specifies more than one data bit.

Dale M. Walsh, U.S. Robotics Inc., 477 East Butterfield Rd., Lombard, IL 60148.

Available Bandwidth

The available telephone channel bandwidth is approximately 200–3200 Hz. Lower speed modems carve out narrow slices near the center where channel distortions are at a minimum. But as you move out from the middle, things get sticky. Band-edge characteristics vary widely from call to call and, near the limits, are extremely hostile to data signals. Modem evolution, as a result, favored development of complex signal alphabets before the final assault on unused bandwidth.

The Bell 103 and other dial-up, full duplex modems belong to a class called Frequency Division Multiplexing (FDM) modems. They send and receive simultaneously using two non-overlapping frequency bands—much like two radio stations tuned at different frequencies. By protocol, the calling modem uses the lower frequency band; hence the terms "Originate" and "Answer" bands. The figure (page 57) shows these bands for the Bell 103 and Bell 212 modems.

Signal States

"One if by land, two if by sea," and Paul Revere was on his way. The flash of light was a data symbol, and one bit per data symbol did the job.

The 300 bit/sec 103 modem uses a similar scheme: one tone for a one and a different tone for zero. It's a fairly simple scheme and easily implemented with today's technology. The Originate and Answer bands each use about 300 Hz of the roughly 3,000 Hz bandwidth that is available.

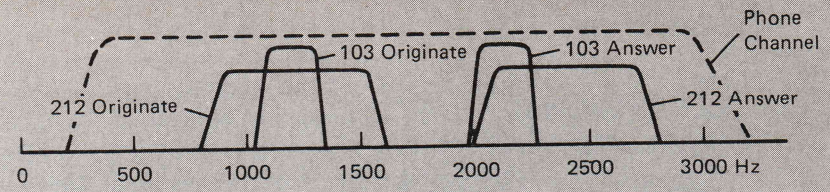
To quadruple data rates to 1200 bit/sec, modem designers made three changes. First, they changed the basic signaling scheme from frequency modulation (as in FM radio) to phase modulation; the latter more efficiently uses available bandwidth. Second, they increased the signaling alphabet from two states (0 and 1) to four states (0, 1, 2, 3); hence, each data symbol uniquely signals two bits. Finally, they doubled the baud rate (the rate at which data symbols are sent from transmitter to receiver) from 300 to 600; this boosted the Originate and Answer bandwidths to approximately 800 Hz each.

These changes significantly increased modem complexity. But LSI technology rode to the rescue. Faster microprocessors handled the modulation and demodulation tasks. More importantly, the complicated 212 analog filters that separate high and low (Answer and Originate) bands were reduced to single LSI chips.

2400

The move from 1200 to 2400 bit/sec distinctly ups the ante.[1] Designers decided not to increase signal bandwidth further, primarily so that they could use 212 filter chips in 2400 bit/sec modems and so that 2400 modems could conveniently fall back to a 212 mode.

Instead, they increased speed by changing the signaling scheme from phase modulation to quadrature amplitude modulation (QAM). In QAM, you can increase the signal alphabet by varying both signal phase and amplitude. A 2400 bit/sec modem sends 16 phase-amplitude combinations. Each combination corresponds to four data bits. Therefore, the modem baud rate between transmitter and receiver is the same for both 212 and 2400, but each 212 data symbol carries two data bits while each 2400 modem data symbol carries four data bits.



SIGNAL BANDWIDTHS

Figure

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Performance

What does this cost? First, design complexity quadruples. The design is more exacting and permits fewer simplifying short cuts.

Second, an inherent performance loss is associated with using 16 different signals rather than four. Imagine a signal system that flashes one of four colors, each color representing two bits. To convert to 16 colors would degrade the system's ability to distinguish colors, especially when they are surrounded by other interfering color flashes.

However, the performance difference between 212 and 2400 modems is not as great as one might expect. The 2400 modems use adaptive equalizers that "learn" telephone channel characteristics, compensating for call-to-call variations. An adaptive equalizer is a little like an auto-focusing camera device that also balances the color spectrum and corrects lens imperfections. Because a sharply focused receiver signal is more noise tolerant, the 2400 receiver can achieve 80–90 percent of its potential noise immunity on every call. Most 212 designs use a compromise equalizer ("one size fits all") approach that sacrifices performance for design simplicity. This difference significantly narrows the performance gap between the two modems.

But, more to the point, how well the 2400 modem works depends on its performance potential compared to the performance limits imposed by the U.S. telephone network. After reading a recent survey of signal levels, noise, and distortions on the U.S. network, one can conclude that well-designed 2400 modems will perform successfully on a very high percentage of such connections. Indeed, this is borne out by units already in the field: a limited test using a U.S. Robotics Courier 2400 modem on long distance connections yielded 95 percent successful calls.

Higher Speeds

Doubling speed from 2400 to 4800 is not as straightforward as going from 1200 to 2400 because 2400 bit/sec is the maximum practical speed for FDM dial-up modems (like the Courier 2400). There are two barriers. First, network changes will make extending the signal alphabet beyond 16 states highly questionable. Second, the remaining option (to use more of the available signal bandwidth) chews up more bandwidth than is available! At 4800 and above, the Answer and Originate bands overlap, and design complexity escalates dramatically.

It *is* possible to mix Transmit and Receive signals in the same frequency band. Each end must ignore its own transmitter and pick up the remote transmitter. This is called echo cancellation. Echo cancellation and adaptive equalization (mentioned above) are similar in that they both "learn" line conditions and adaptively compensate. But echo cancellation requires more computations with about twice as many bits of arithmetic. Several European modems successfully use echo cancellation, but they are fairly expensive compared to 2400 bit/sec modems.

CCITT recommendation V.32 defines a new dial-up 9600 bit/sec modem that includes a 4800 bit/sec mode. The Originate and Answer bands completely overlap, and each occupies 90 percent of the available bandwidth. Originally, the modem was conceived for local access to digital data networks. However, added features now allow long haul operation on international circuits and in large countries like the U.S.

Recommendation V.32 is very new and subject to change as the first models are introduced. Measured by computations per second and bits of resolution, these modems are roughly 64 times more complex than 2400 bit/sec modems. For this reason, it will be quite some time before V.32 modems can compete in the high-volume modem market.

Notes

[1] The discussion here concerns dial-up, full duplex modems in the 103 and 212 class. Leased-line modems typically operate 4,800–14,400 bit/sec.

DDJ

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C UART Controller

by Don Gay

This article describes a program that allows easy modification of the parameters of a programmable USART. The program, written in C, is readily adapted to a number of different UART chips. This particular program is for the Signetics/National Semiconductor 2651 USART.

Recently, I constructed a serial port board to let me use a modem on my microcomputer. After looking at some of the designs in *Interfacing to S-100/IEEE 696 Microcomputers*[1] and checking the local availability of UART chips, I decided to implement the design on page 183 of the book, which makes use of the 2651 USART.

This USART is fully programmable with respect to baud rate, stop bits, parity, word length, and so on, and changes to my BIOS would program the USART at boot time. However, I needed more flexibility. When transferring files to an adjacent machine, I would have appreciated a simple way to change the USART parameters, namely, the baud rate, resetting it for higher rates.

SETP.C

The Listing on page 62 shows the results of my attempt at solving this problem. The program is called with a number of command line switches, which can be used to modify the port parameters. I have designed the program to run entirely from the command line to make it easily adaptable to systems that have an autoexecute on boot: anyone can boot up in whatever mode is required without modifying the BIOS.

An examination of the listing reveals four command line switches. These allow the user to change the baud rate (–b), number of stop bits (–s), parity (–p), and word length (–l). All invalid switches are ignored, as are values out of range for any of the parameters. After all command line switches have been effected, the program shows the values of all the port parameters. Trying to execute the program with no switches on the command line produces a "Usage" description, followed by the current port parameters. Here is an example of how the program typically is called:

```
A> setp –b1200 –s1 –pn –l8
```

This would configure the USART to transmit/receive at 1200 baud, 1 stop bit, no parity, and a character length of 8 bits.

A tasty little morsel from Wahroonga.

USART Programming Details

A 2651 USART uses four consecutive I/O ports:

(1) Transmit/Receive holding register
(2) Status register
(3) Mode register 1 and 2
(4) Command register

The USART parameters are controlled by writing to the mode registers. By reading the values in the mode registers, you can determine the current parameters of the USART.

There are actually two mode regis-

Don Gay, 136 Fox Valley Road, Wahroonga, 2076, N.S.W., Australia.

ters at the same I/O address, each accessed by a consecutive read or write. Read from the mode register once and you will get the contents of one of the mode registers; read from it again and you will get the contents of the other mode register. A similar situation exists for writing. After a reset, the first read/write accesses the first mode register. As long as reading and writing are done in pairs, you will always know with which register you are dealing.

The command register controls the level of *RTS and *DTR lines, as well as enabling and disabling transmit/receive. Because the values written to the command register need not change once the port has been initialized, the program does not allow alteration of the command register from the command line switches. These switches alter only the contents of the mode registers.

As is usually the case with programmable peripheral interfaces, each bit has a special significance in the controlling mode registers. Figures 1 and 2 (at right) show the importance of each bit in the mode registers of the 2651.

The USART is configured in this program in asynchronous mode with internal receive and transmit clocks. This is probably the most common mode used with ordinary devices, such as modems and terminals, so these characteristics are "hard coded" in the program. Refer to the 2651 documentation[2] to find out other ways to operate the port.

References

[1] Sol Libes and Mark Garetz. *Interfacing to S-100/IEEE 696 Microcomputers.* California: Osborne/McGraw-Hill, 1981.

[2] National Semiconductor Data Sheet. "INS2651 Programmable Communications Interface." October 1980.

DDJ

(Listing begins on next page)

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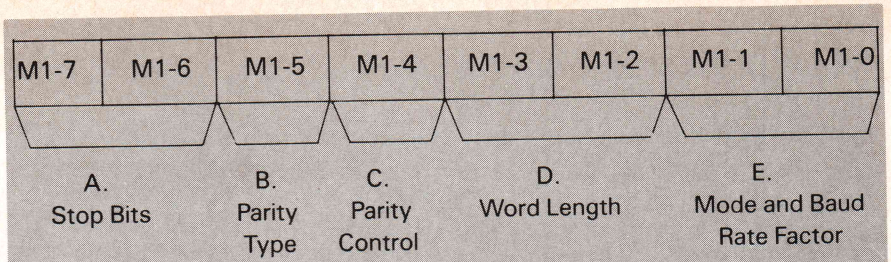


A. Stop Bits
- 00 = Invalid code.
- 01 = 1 stop bit.
- 10 = 1.5 stop bits.
- 11 = 2 stop bits.

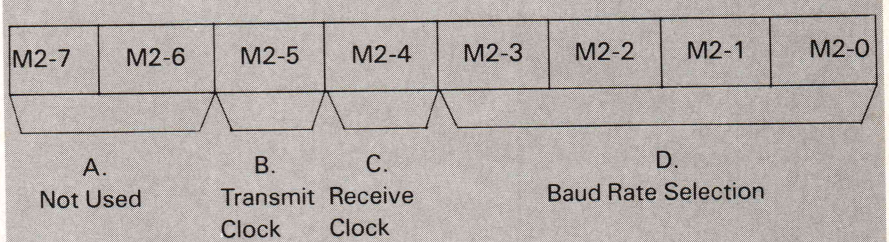
B. Parity Type
- 0 = Odd.
- 1 = Even.

C. Parity Control
- 0 = Disabled.
- 1 = Enabled.

D. Word Length
- 00 = 5 bits.
- 01 = 6 bits.
- 10 = 7 bits.
- 11 = 8 bits.

E. Mode and Baud Rate Factor
- 00 = Synchronous mode (not used).
- 01 = Synchronous mode (not used).
- 10 = Asynchronous mode 16x rate.
- 11 = Asynchronous mode 64x rate.

Figure 1
Mode Register 1 Format



A. Not Used

B. Transmit Clock
- 0 = External clock
- 1 = Internal clock

C. Receive Clock
- 0 = External clock
- 1 = Internal clock

D. Baud Rate Selection (only for async 16x mode)

0000 = 50 baud	1000 = 1800 baud
0001 = 75 baud	1001 = 2000 baud
0010 = 110 baud	1010 = 2400 baud
0011 = 134.5 baud	1011 = 3600 baud
0100 = 150 baud	1100 = 4800 baud
0101 = 300 baud	1101 = 7200 baud
0110 = 600 baud	1110 = 9600 baud
0111 = 1200 baud	1111 = 19200 baud

Figure 2
Mode Register 2 Format

C UART Controller Listing (Text begins on page 60)

```
/*************************************************************************/
/*                                                                       */
/*          Serial Port Configuration Program  (2651 PCI)                */
/*                                                                       */
/*   Source filename  : SETP.C                                           */
/*   Program Language : C/80 3.0 (Software Toolworks)                    */
/*   Program Author   : Don Gay                                          */
/*   Last Revision    : June 11, 1984                                    */
/*                                                                       */
/*************************************************************************/

#include printf.h                    /* Header for formatted output */

#define REV_DATE        "11/06/84"

#define PORT_BASE       0               /* 2651 PCI base address    */
#define MODE_REG        PORT_BASE+2     /* Mode register            */
#define CMND_REG        PORT_BASE+3     /* Command register         */

#define DISABLE         0x32            /* Disable UART recv/xmit   */
                                        /* Force *DTR and *RTS low  */
#define ENABLE          0x37            /* Enable UART recv/xmit    */

/* Store legal values for all paramters */

char *baudr[] = {"50","75","110","134.5","150","300","600",
                 "1200","1800","2000","2400","3600","4800",
                 "7200","9600","19200"},
     *sbits[] = {"0","1","1.5","2"},
     *parit[] = {"N","O","N","E"},
     *wordl[] = {"5","6","7","8"};

int baud_rate, stop_bits, parity, word_length;

main(argc,argv)
int argc;
char *argv[];
{
   printf("\nSerial port configuration program as of %s\n",REV_DATE);
   get_prm();                       /* get current port parameters */
   if (argc>1)                      /* process the command line */
      while (argc-- > 1)
         process(argv[argc]);
   else                             /* Give some help */
      show_usage();
   show_prm();                      /* Display parameters */
   set_prm();                       /* Re-program PCI     */
}

process(arg)                        /* Try to match the command line */
char *arg;                          /* argument with a valid switch  */
{                                   /* If valid, set up new value    */
   int n;
   if (*arg == '-') {
      switch(toupper(*++arg)) {
         case 'B': n=match(++arg,baudr,16);
                   if (n>=0) baud_rate=n;
                   else error("baud rate value",arg);
                   break;
         case 'S': n=match(++arg,sbits,4);
                   if (n>=0) stop_bits=n;
                   else error("stop bits value",arg);
                   break;
         case 'P': n=match(++arg,parit,4);
```

(Continued on page 64)

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```
                    if (n>=Ø) parity=n;
                    else error("parity value",arg);
                    break;
            case 'L': n=match(++arg,wordl,4);
                    if (n>=Ø) word_length=n;
                    else error("word length value",arg);
                    break;
            default : error("switch",arg); break;
        }
    }
    else
        error("switch",arg);
}

match(value,table,size)                 /* Check if switch value is valid */
char *value,                            /* Command line value */
     *table[];                          /* Table of valid arguments */
int size;                               /* No. of entries in table */
{
    int ndx;

    ndx=Ø;
    while ((ndx<size) && (strcmp(value,table[ndx]) != Ø))
        ndx++;
    return( ndx<size ? ndx : -1 );/* Return -1 if not found */
}

get_prm()                               /* Read mode ports to determine */
{                                       /* current port parameters      */
        int mode1,mode2;

        mode1 = input(MODE_REG);/* get mode register 1 */
        mode2 = input(MODE_REG);/* get mode register 2 */

        baud_rate   = getbits(mode2,3,4); /* isolate bit fields */
        stop_bits   = getbits(mode1,7,2);
        word_length = getbits(mode1,3,2);
        parity      = getbits(mode1,5,2);
}

getbits(x,p,n)                          /* get n bits from position p */
unsigned x, p, n;                       /* Ref: K&R pg 45 */
{
        return((x >> (p+1-n)) & ~(~Ø << n));
}

set_prm()                   /* Re-program PCI with new parmameters */
{
        int mode1, mode2;

        mode1 = Øx02 |                      /* set asynch. 16x mode */
                (  stop_bits   << 6) |  /* merge parameters     */
                ( (parity      << 4) & Øx3Ø ) |
                ( (word_length << 2) & ØxØc );

        mode2 = Øx3Ø |                      /* set internal clock   */
                baud_rate;                  /* merge baud rate      */

        output(CMND_REG,DISABLE);           /* disable recv/xmit    */
        output(MODE_REG,mode1);             /* send new parameters  */
        output(MODE_REG,mode2);
        output(CMND_REG,ENABLE);            /* now enable PCI       */
}
```

```
show_parm()                          /* Display current parameters */
{
        printf("\nBaudrate    : %s\n",baudr[baud_rate]);
        printf(  "Stopbits    : %s\n",sbits[stop_bits]);
        printf(  "Parity      : ");
        switch(parity) {
           case Ø: printf("None\n"); break;
           case 1: printf("Odd\n"); break;
           case 2: printf("None\n"); break;
           case 3: printf("Even\n"); break;
        }
        printf(  "Wordlength : %s\n",wordl[word_length]);
}

show_usage()
{
   printf("\nUsage: SETPORT [-Bb][-Ss][-Pp][-Ll]\n\n");
   printf("       where -Bb sets Baudrate,   b = 5Ø..19200\n");
   printf("             -Ss sets Stopbits,   s = Ø, 1, 1.5, 2\n");
   printf("             -Pp sets Parity,     p = O, E, N\n");
   printf("             -Ll sets wordLength, l = 5, 6, 7, 8\n");
}

error(type,value)                    /* Warn command line argument error */
char *type, *value;
{
   printf("Illegal %s ignored : %s\n",type,value);
}

input(port)                          /* Return input from I/O port */
int port;
{
#asm
        pop     b               ;Return address
        pop     h               ;Port number
        push    h               ;Restore stack
        push    b
        mov     a,l             ;Get port into A
        sta     inadr           ;Modify next instruction------+
        in      Ø               ;Dummy input instruction      ¦
inadr   equ     $-1             ;Actual port gets poked here <+
        mov     l,a
        mvi     h,Ø
#endasm
}

output(port,byte)                    /* Output to I/O port */
int port, byte;
{
#asm
        pop     b               ;Return address
        pop     d               ;Byte to output
        pop     h               ;Port number
        push    h               ;Restore stack
        push    d
        push    b
        mov     a,l             ;Get port into A
        sta     outadr          ;Modify next instruction--------+
        mov     a,e             ;Get byte to output             ¦
        out     Ø               ;Dummy output instruction       ¦
outadr  equ     $-1             ;Actual port gets poked here <--+
        mov     l,a
        mvi     h,Ø
#endasm
}
```

End Listing

Christensen Protocols in C

by Donald Krantz

About two years ago, when I acquired my first 8-inch machine, I needed a file transfer program to load data between the 8-inch machine and my 5¼-inch machines. I started looking around for a version of MODEM7 on 8-inch disk.

Before I found one, I ordered a couple of 8088 co-processors for my systems. As this development promised to complicate my file transfer problems considerably, I decided to write a file transfer utility in C so I would have a single, portable program for all my systems.

I started writing in SuperSoft C, because that was what I had back then, and several weeks later had a version working on my Zorba CP/M machine. I thought I'd be in Fat City when the co-processors came.

Well, the co-processors arrived, I wired them in, and I started planning the big port. I was unpleasantly surprised to find that the co-processors had no assembler or documentation and wouldn't read my 5¼-inch IBM disks. As far as I could tell, I had no means of getting any new programs or files into the system short of writing a program with DEBUG. This was unacceptable, especially since I had promised myself that I would never learn nor use 8088 assembly language and had given myself a waiver only to port the source for the file transfer program.

I put the 8088s aside and continued with my life. As time passed, I used the file transfer program, which by now had the name XFR, and gradually started adding bells and whistles.

Some time later, I had occasion to write XMODEM in C for my portable BBS series. I thought I'd just take the old XFR program and do a little surgery; I figured the whole thing ought to take no longer than a couple of hours.

By this time, I had switched all of my new program development to Eco C, which is closer to the Unix Version 7 standard than was SuperSoft. As I started work on XMODEM, I found more and more places where the basic structure of XFR made porting the thing less and less attractive. Still, I took out the digital chain saw and started to work on XFR.

Some of the items I took out include an assembly language CRC generator, interrupt-driven receive FIFO, XDIR-style directory, wildcard filename expansion for the batch mode, file eraser, disk drive logger, half duplex and host terminal mode, and a data line monitor for watching control characters. What's left is a basic Christensen protocol engine with a minimal terminal program. The advantage is that the file transfer primitives are now pretty much independent of the operating system and C compiler—to the extent allowed by the protocol—and can be dropped

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Donald Krantz, 2845 42nd Ave. South, Minneapolis, MN 55406.

into other environments easily.

The basic features supported by XFR are dumb terminal emulation with host system terminal attributes and checksum or CRC file transfer in single or batch file mode. I'll run through the Listing (page 71) and discuss features and portability considerations on a function-by-function basis. First, let me mention up front that my goal was operation at 19.2K-baud, so I have violated some software development standards in the interest of speed, specifically by using C's interfunction GOTO to reduce conditionals in loops. Also, Z80 implementations of C tend to access globals faster than automatics, so globals perhaps are overused.

Function main( )

This is basically a menu processor. Most of the functions do returns rather than using the longjmp( ) to resume the menu loop. It's a trivial job to add features to the menu if you plan on actually using this as a terminal program and need more functions.

Function term( )

This is a simple dumb terminal. For you MSDOS or Unix folks who haven't memorized the CP/M BDOS function calls, the function _bdos(6, 0xFF) is a specialized version of getchar( ) that immediately returns a NULL if no character is waiting. I've seen a similar function, sometimes called inkey( ) or keyscan( ), in other C libraries. The presence or absence of term( ) doesn't affect the file transfers at all, but because you usually should be able to communicate with the remote system to set up the file transfer, it's nice to have some sort of dumb terminal.

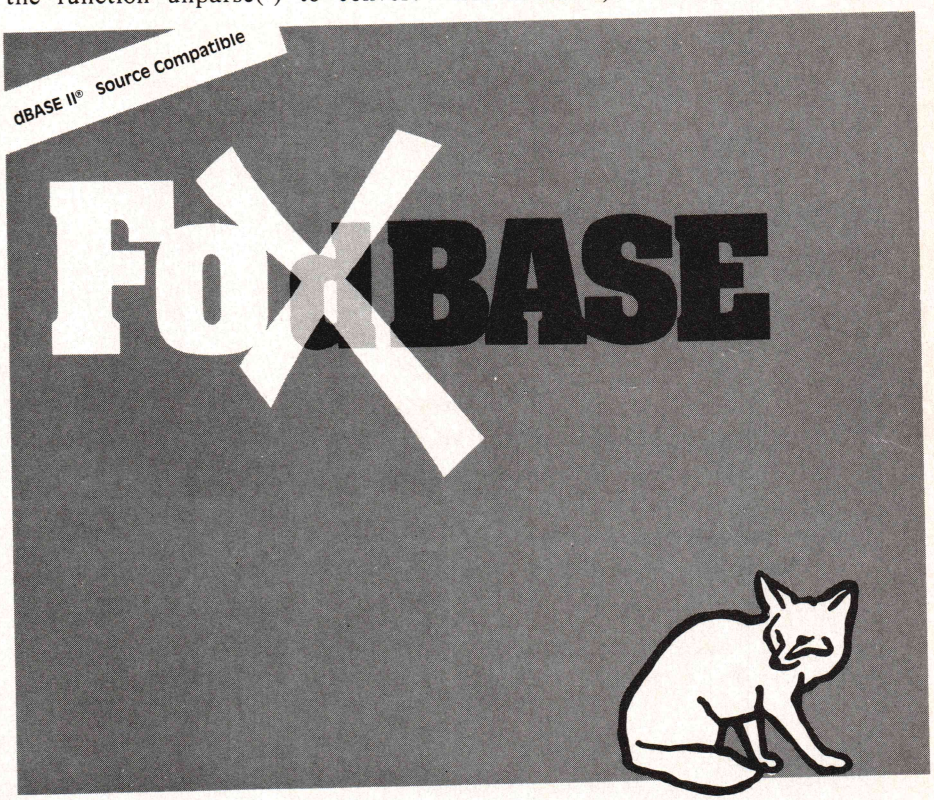
Function transmit( )

This function has the only cheezy user interface in the program. It selects batch file transfer, as opposed to single file transfer, by looking for a comma at the end of the input line when asking for the transmit filename; should it find a comma, it will select batch mode and ask for the next name. Most versions of MODEM7 either have a command option switch for this purpose or recognize that you want batch mode if an ambiguous filename is specified. The original XFR used the latter method. Unfortunately, there is no portable way to expand filenames and get a list of matching files.

If you have a system that will expand wildcards on the command line and pass matching names through the argc/argv method, you could easily convert this program from interactive to command line mode. Otherwise, on CP/M systems, if you have access to the BDOS calls, you can use the function unparse( ) to convert CP/M fcb names to a normal format and pass them one at a time to trans( ). The one advantage the current method has over wildcard expansion is that it allows sending files with dissimilar names. However, if you do use the CP/M "search for file" and "search for next" calls, be sure to collect all the names before you allow the program to proceed.

Function trans( )

This is the file transmission primitive executive (if that's not a contradiction in terms). A filename is passed



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in, in a format compatible with the fopen( ) function. If batch mode is selected, the name is sent to the remote system, followed by the file itself. This function, and the supporting functions it uses, are all pretty much system independent within the confines of the protocol.

Function txrec( )

This function sends a single record to the remote system and does any retransmission necessary due to errors. The record size is fixed at 128 bytes by the macro RECSIZE. If you don't need compatibility with the rest of the world, you could try optimizing performance by increasing the size of the record, if you have a good communication link, or decreasing the size of the record if you use noisy

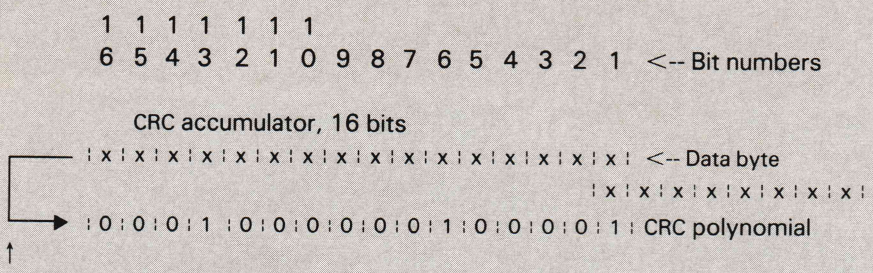

Figure 1.
A 1 shifted out of the left end of the CRC accumulator causes the CRC polynomial to be exclusive-ORed with the post-shift CRC accumulator. The CRC polynomial appears to have no relation to the polynomial equation in the text until you realize that it has been shifted left along with the accumulator.

Byte Number	Definition
1	SOH (Start of Header)*
2	Record number mod 256*
3	[One's complement of record number*
4	Data byte 1
.	
.	
131	Data byte 128
132	CRC high byte†
133	CRC low byte†

* Not included in CRC or checksum calculation
† Included as zeros in CRC calculation

Figure 2.
Christensen packet makeup is shown for a CRC error detection packet. In checksum, byte 133 is not sent, and byte 132 is the checksum.

Programmers writing MODEM7-compatible programs traditionally learn about the protocol by getting as many copies of the source to MODEM7 as possible and tracing program flow. In violation of that tradition, I have written down my interpretation in English. Glock's Fourth Law states that this must have been done before, but the corollary to that law states that you can't find out where, even if it has.

Ward Christensen (according to legend) developed the protocol, which was extended by several other people who ought to receive credit but whose names I don't have. Ward has been around so long that I was surprised, and perhaps a little indignant, to find that he is still alive. He is responsible for some of the more clever public domain programs, so I'm willing to bet that he didn't do some of the peculiar things in the Christensen protocol—such as the filename transfer.

There are two levels to the Christensen (also called XMODEM) protocol: file-at-a-time and batch transfer. The batch transfer mode provides for the unattended transmission of multiple files, including the filename.

The protocol uses two different error detection schemes: checksum and CRC (Cyclic Redundancy Code). Older versions of MODEM7 use the checksum method, while the newer versions use the more accurate CRC method. Most programs that can do CRC will also do checksum.

Only the data bytes in a packet are included in the calculation of the error detection code. The protocol handles errors in headers and handshakes by ignoring garbage characters or assuming the worst.

Checksums are calculated by adding all data bytes mod 256, with any carry ignored.

The CRC polynomial used is the

lines. The macro RECSIZE fixes all the parameters necessary for change of record size.

Function txname( )

This function sends a filename to the remote system when batch mode is selected. The protocol calls for a fixed 11-character field in CP/M fcb format. This part of the protocol has a slightly different flavor to it than the rest, so I suspect that somebody other than Ward Christensen did it. If you're not interested in compatibility with MODEM7, the size of the name is fixed by the macro NAMESIZE. You're safe up to about 30 characters or so before you have to start hunting for other items affected by the name size that NAMESIZE doesn't control.

CCITT $X^{16} + X^{12} + X^5 + 1$. I'm told that there are people who know what that means (I'm taking the word of an old XMODEM listing). In simple language, the procedure for generating the CRC is this: A byte to be added to the CRC is fed into the generator, one bit at a time, high bit first. The bit is shifted into a 16-bit CRC accumulator low end. If the high bit shifted out of the CRC accumulator is a 1, the CRC accumulator is exclusive-ORed with 0x1021. The process repeats for all eight bits of the input character. See Figure 1 (page 68).

In the case of the Christensen protocol, after all the data bytes in a given packet are sent through the CRC generator, two zero bytes are sent through at the end. I'm guessing that these bytes take the place of the CRC bytes in the packet, although I don't know why this is needed. I do know that it doesn't come out right unless you do this, and for an empirical kind of guy like myself that's plenty good enough.

At the single file level of the protocol, both systems are told to begin, and the transmitter waits for the receiver to send a sync byte. The initial sync byte tells the transmitting system whether CRC or checksum will be used. If checksum, the sync byte is a NAK. If CRC, the sync byte is a 'C.' If the receiver is thinking CRC and the transmitter isn't capable of it, both systems hang until they time out. Some programs send five or six 'C' sync bytes and, if not answered, then send NAKs in case the transmitter is an old version.

In CRC mode, once the systems are in sync, the 'C' is dropped in favor of ACK/NAK handshaking for subsequent records.

Once in sync, the transmitter sends a packet consisting of an SOH character, the record number mod 256, the one's complement of the record number, a 128-byte data block, and the error detection byte(s). See Figure 2 (page 68).

The receiver must accept the entire packet at once. Most versions of MODEM7 wait for the SOH, so a missed SOH is an error from which it is difficult to recover. After reception, conditions that will cause record rejection are: the record number doesn't match the one's complement of the record number; the error detection number doesn't match; SOH is not intact; and the record number either is not the record number expected or is one less than the record number expected (indicating a previous ACK was trashed). If the record is rejected, the receiver sends a NAK to the transmitter, which retransmits the record. If the record is accepted, the receiver sends ACKs at about one-second intervals until the next SOH.

This process repeats until all records are transmitted. At the end of file, the transmitter sends EOT at one-second intervals until the receiver ACKs the EOT.

Record numbers are "natural" numbers; that is, the first record is numbered 1, as opposed to the computer natural 0.

Batch level of the protocol includes a filename header in front of the file. Filenames always use checksum error detection, even if CRC mode is selected for the rest of the file. The filename is sent as it would appear in a CP/M file control block (fcb), a fixed block, 11 characters long, with blanks expanding the dot should the filename be less than 11 characters. It is important in CP/M systems to make sure that any high bits are stripped from the filename. See Figure 3 (page 69).

When preparing to receive a name, the receiver sends NAKs at about one-second intervals until the transmitter responds with an ACK followed by the first character of the filename. The receiver then handshakes with ACKs until the transmitter sends EOF. This may mean that more than 11 characters are received (because of line noise). When the receiver gets the EOF, it responds with the checksum of the name, including the EOF byte. If the checksum matches, the transmitter sends an ACK, and the single file process takes over. If the checksum doesn't match, the transmitter sends a NAK, and the process repeats.

If the transmitter sends an EOT in place of any name character, it causes batch transfer mode to terminate. This is the normal end to a batch transfer.

Both the transmitter and the receiver should be able to recognize CAN (Cancel) in place of ACK, NAK, EOT, SOH, or EOF. In practice, timeouts will replace some tests for CAN.

All transmit and receive loops should have timeouts and retries built into them to avoid hanging if the two systems get out of sync.

Standard UART setting for the Christensen protocol is eight bits, no parity, one stop bit.

TEST.DOC becomes:	¦T¦E¦S¦T¦ ¦ ¦ ¦ ¦D¦0¦C¦
VERY.LONG.NAM becomes:	¦V¦E¦R¦Y¦L¦O¦N¦G¦N¦A¦M¦
NAME becomes:	¦N¦A¦M¦E¦ ¦ ¦ ¦ ¦ ¦ ¦ ¦

Figure 3.
CP/M filename expansion

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Function receive( )
This is the file reception primitive executive. All it really does is figure out if you want batch mode or single file mode. It's not possible to tell what the other system has selected just by listening to the line. If an asterisk is entered in the receive filename specification, batch mode is selected while preserving any drivespec. Those with non-CP/M systems could remove the drivespec material, but this probably won't be necessary. It's triggered by a colon in the second character position of the filespec.

Because the Christensen protocol is receiver driven, you have to have made a choice whether to use checksum or CRC error detection before you initiate the receive mode. Some versions of MODEM7 will hunt back and forth between CRC and checksum mode to match what the other system uses, but this program doesn't.

Function rxbatch( )
This takes over as receive executive if batch mode is selected. It receives a filename from the remote system and converts it from the fcb format used for transmission back to a format suitable for use with C functions. The name is then passed to the file receive function rxfile( ) to pick up the body of the file.

Function rxname( )
This is the companion to txname( ). Enough said.

Function rxfile( )
This handles reception of an entire file. This function is the time-critical part of the program, which is why I didn't break it into smaller modules. It doesn't matter if the program is slow when transmitting, but when receiving you have to catch all of the characters sent from the other end as they come in. I put off the computation of checksum or CRC to the end of the record for this reason, instead of building it into the receive character function where it probably belongs.

It's also important not to output messages to the display when a packet transfer is in progress. One of the versions of MODEM7.11 that is floating around can't run above 1200 baud in receive mode because it makes a message output call immediately after receiving the packet header and so misses a couple of characters.

Function make( )
This opens a file to receive to. The original version of XFR made a backup file if a file would be overwritten, but file renaming isn't portable in C (the current version will happily destroy an old file, even if reception is terminated prematurely). I left the code in a false conditional assembly block because I thought it rather clever; it's a good feature if your C library supports renaming. The function link takes the arguments (newname, oldname).

Function parse( )
This takes a filespec useable by C functions and converts it to the CP/M fcb format needed by the Christensen protocol. On systems with pathnames, you'll have to hack this function into shape to deal with filename preambles. It will operate on names that don't follow CP/M conventions in most circumstances, although the use of periods will give some unusual results. If the NAMESIZE macro is resized, parse( ) will still operate in a reasonable manner.

Function fillbuf( )
This loads the transmit file buffer with a record. I modularized this section because soon I'll add the ability to extract members from a library file. On systems capable of file sizes that aren't multiples of system records, this function pads the last record with zeros. Note that this code will never be executed on a CP/M system.

Function unparse( )
This undoes what the parse( ) function does. Notice that a period always is inserted into a filename unless the filename is less than (NAMESIZE–3) characters long.

Function updcrc( )
This adds a character to the CRC or checksum accumulator. This uses the CCITT CRC polynomial, but characters are fed into the generator high

bit first. I'm not certain, but I think that makes it incompatible with communications chips that do a hardware CRC, in case you have thoughts in that direction. At any rate, look into it before you spend a lot of time on it.

Function abort( )

This scans the console for an operator-requested abort. As far as I know, this function is called inside any loop where the system can hang (but I never guarantee anything about a program). The BDOS keyboard scan is the same as in term( ).

Function error( )

This is called when fatal transmission or reception errors occur. It ties up loose ends then jumps back to the menu.

Functions wait( ), swait( ), and waitcan( )

These do different delays while waiting for characters. You could combine them all into one function if you're willing to pay the overhead for more conditionals. At high baud rates, file reception timing is pretty critical, but for 1200 baud or so there won't be any problems.

Remaining Functions

In CP/M systems, all of the above functions should work as is. The rest of the functions are all machine dependent—or potentially so.

The init( ) and quit( ) functions are called at the beginning and end of the program. I had code to set up and remove an interrupt-driven FIFO in these functions; UART initialization or I/O channel acquisition would probably go here as well.

The I/O primitives are set up for an I/O-mapped Intel 8351A UART. These functions are the ones most likely to require customization to make the program work.

How does the whole thing perform? On a Z80 running at 3.58 MHz, the program will easily do transfers in checksum mode at 19.2K baud. I'm reasonably sure it will do the same in CRC mode, but I haven't the resources to test CRC at that speed. If anyone does do a benchmark, I'm interested in the result.

As far as error handling, the program is not ready for an end user, but a reasonable person would have to work at it to blow the thing up. Consider this a starting point, and if anyone gets it up on 8-inch MSDOS for the Bigboard and Co-Power 88, let me know.

Source is available on TCOG BBS (612) 724-7779 300/1200 baud.

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Protocols Listing (Text begins on page 66)

```
/*-----------------------------------------------------------------
                            XFR
                    By Donald G. Krantz 3/84
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XFR is a packet protocol file transferer similar to modem7. It is
designed for 19.2K baud transfers "nose-to-nose" between computers
and works very well in modem use at low speeds. XFR is compatible
with most versions of Modem7.

-----------------------------------------------------------------*/

#include "stdio.h"              /* ECO C */

/*-----------------------------------------------------------------
ASCII and XMODEM control characters
-----------------------------------------------------------------*/

#define SOH 1                   /* start of header              */
#define EOT 4                   /* end of transmission          */
#define ACK 6                   /* true acknowledge             */
#define NAK 0x15                /* false acknowledge            */
#define CRC 'C'                 /* request CRC mode             */
#define CAN 0x18                /* cancel transmission          */
#define EoF 26                  /* end of file (used for name)  */
#define BADNAME 0x75            /* received bad name checksum   */
#define BELL 7                  /* console bell                 */
#define NEWLINE 10              /* linefeed char                */
#define CR 13                   /* carriage return char         */
#define BS 8                    /* backspace character          */
#define ESCTERM 'E'-'@'         /* escape from terminal mode    */

/*-----------------------------------------------------------------
User accessable system equates
-----------------------------------------------------------------*/

#define RETRY 5                 /* no. of retrys before abort   */
#define RECSIZE 128             /* transfer record size         */
#define NAMESIZE 11             /* filename fixed length        */
#define TITLE printf( "\n\t\t\t  XFR - File Transfer Utility")
#define VERSION printf("\n\t\t\t ZORBA Version 2.00 as of 3/85")
#define CLS printf( "\033E")    /* clear screen                 */
```

(Continued on next page)

```
#define ERROR -1
#define MAGIC_NUMBER 10000      /* time constant - machine dep. */
#define VOID int                /* function type                */
/* #define LINK                 / * file rename supported       */

/*-----------------------------------------------------------------
Machine dependant port addresses - ZORBA Version (Intel 8251A)
-----------------------------------------------------------------*/

#define RXDATA 0x20             /* rec'd data UART port         */
#define TXDATA 0x20             /* tx'ed data UART port         */
#define UARTCMD 0x21            /* Command/Status port          */


/*-----------------------------------------------------------------
Global variables
-----------------------------------------------------------------*/

char *line;                     /* scratch input line           */
char *buffer;                   /* record buffer                */
FILE *fd;                       /* file POINTER!                */
unsigned rec;                   /* record number                */
char checksum;                  /* checksum accumulator         */
unsigned crcaccum;              /* global crc bytes             */
char crc;                       /* CRC on/off flag              */
char batch;                     /* batch on/off flag            */
jmp_env to_menu;                /* long jump envelope           */
struct {                        /* batch list array             */
                char name_part[ 32 ];
        } list[ 32 ];

/*-----------------------------------------------------------------
Function type declarations
-----------------------------------------------------------------*/

VOID main(), term(), transmit(), trans(), txname(), txrec();
VOID receive(), rxname(), rxfile(), make(), error(), clrcrc();
VOID updcrc(), abort(), sleep(), quit(), init(), tx(), rxbatch();
char *index(), *parse(), *unpa se();
int fillbuf(), wait(), swait(), waitcan(), rxstat(), rx();
int txstat();

/*-----------------------------------------------------------------
Executable code follows.

main() is (of course) the master program loop. Uses setjmp()
to un-nest function calls on error exits.

References globals: crc, tty;
Modifies globals: crc, tty;
-----------------------------------------------------------------*/

VOID main()
{
   char menu;

        menu = FALSE;           /* initially expert mode        */
        init();                 /* initialize modem and UART    */
        TITLE;
        VERSION;
        printf( "\nType 'M' for MENU display....");
        setjmp( &to_menu );     /* menu loop                    */
        while( TRUE )
        {
                printf( "\n\nMode: %s", crc ? "CRC" : "Checksum" );
                if( menu )
                {
                  printf( "\n\n\tS Send file    R Receive file\n" );


                  printf( "\tT FDX term     V CRC/Checksum\n" );
                  printf( "\tM toggle menu  X Exit\n" );
                }
                printf( "\n\nCommand: " );
                switch( toupper( getchar() ) )
                {
                        case 'S':               /* send file(s) */
                                transmit();
                                break;
                        case 'R':               /* RX file(s)   */
                                receive();
                                break;
                        case 'T':               /* dumb terminal*/
                                term();
```

(Continued on page 74)

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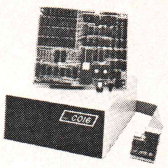

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```
                        break;
                case 'V':               /* toggle crc   */
                        crc = !crc;
                        break;
                case 'M':               /* toggle menu  */
                        menu = !menu;
                        break;
                case 'X':               /* quit         */
                        quit();
                default:                /* option bad   */
                        putchar( BELL );
                }
        }
}


/*---------------------------------------------------------------
term() is the dumb terminal section. Escape by typing ESCTERM
character (see ASCII #defines).
Some machine dependent stuff.
---------------------------------------------------------------*/

VOID term()
{
   char ch;                             /* scratch char         */

        CLS;
        printf( "\n\n" );
        while( TRUE )                   /* the loop.            */
        {
                if( rxstat() )          /* if char coming in    */
                        putchar( rx() );/* display local        */
                if( (ch = _bdos( 6, 0xFF )) != NULL )
                        if( ch == ESCTERM )     /* check exit   */
                                return;
                        else
                                tx( ch );       /* disp remote  */
        }
}

/*---------------------------------------------------------------
transmit() is the transmission executive. It requires no input
parameters. This function takes filename(s) as input from the
user, one line at a time. A comma at the end of a filename
signals the intention to enter anther filename on the next
line. More than one filename entered sets "batch" mode. 32
names maximum, for no especially good reason.

Modifies globals: buffer, batch;
---------------------------------------------------------------*/

VOID transmit()
{
   int ct = 0;
   int i;

        printf( "\n" );
        while( TRUE )
        {
                printf( "Transmit File specification: " );
                gets( list[ ct ].name_part );
                if( index( list[ ct ].name_part, ',' ) == NULL )
                        break;
                *index( list[ ct ].name_part, ',' ) = '\0';
                ct++;
        }
        batch = (ct ? TRUE : FALSE);
        for( i=0 ; i <= ct ; i++ )
        {
                while( rxstat() )       /* gobble garbage       */
                        rx();
                trans( list[ i ].name_part );   /* send file    */
        }
        if( batch )
        {
                while( swait() != NAK ) /* await name request   */
                        abort();        /* operator abort scan  */
                tx( ACK );              /* handshake NAK        */
                sleep();                /* decent interval      */
                tx( EOT );              /* end of transmission  */
        }
}
```

(Continued on page 76)

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B1: JSMITH  .LTR   2K | 16:30-24 Dec'84  11:59-10 Feb     16:30-24 Dec'84
B1: TEST1   .BAS   4K | 09:34-22 Jan     16:27-30 Jan     09:35-22 Jan
B1: TEST2   .BAS   4K | 11:55-01 Feb                      11:55-01 Feb
```

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Protocols Listing

(Listing continued, text begins on page 66)

```
/*-------------------------------------------------------------
trans() does transmission of a file.

References globals: buffer, fd, batch;
Modifies globals: fd, rec, crc;
-------------------------------------------------------------*/

VOID trans( in_name )
   char *in_name;
{
   char name[ NAMESIZE+1];       /* expanded name                */

   char ch;                      /* scratch character            */
   register char *i;             /* buffer pointer (index)       */
   int y;                        /* scratch counter              */

        rec = 1;                 /* uses "natural" numbering     */
        if( (fd = fopen( in_name, "rb" )) == NULL)
        {
                printf( "Unable to open: %s\n", in_name );
                return;
        }
        if( batch )              /* need to send name?           */
                txname( parse( in_name, name ) );
        printf( "\nTransmitting: %s", in_name );
        while( rxstat() )
                rx();
        while( TRUE )            /* handshake w/ receiver        */
        {
                printf("\nSyncronizing: " );
                if( (ch = waitcan( 10 )) == NAK )
                {
                        printf( "Received Checksum Request\n" );
                        crc = FALSE;
                        break;
                }
                if( ch == CRC )
                {
                        printf( "Received CRC Request\n" );
                        crc = TRUE;
                        break;
                }
        }
        while( fillbuf() )               /* file not empty?      */
                txrec( buffer );         /* send record          */
        tx( EOT );
        while( (ch = waitcan( 1 )) != ACK )
        {
                tx( EOT );               /* show end             */
        }
        fclose( fd );                    /* dump file            */
        printf( "\n%s transferred.", in_name );
}


/*-------------------------------------------------------------
txname() transmits a file name from the CP/M fcb format
parameter 'name'.

References globals: buffer, checksum, crc;
Modifies globals: crc;
-------------------------------------------------------------*/

VOID txname( name )
   char *name;
{
   register int i;               /* scratch counter              */

   char ch;                      /* scratch char                 */
   char crcsav;                  /* holds state of global 'crc'  */

        crcsav = crc;            /* we always use checksum for   */
        crc = FALSE;             /* name error detection         */
        while( TRUE )            /* main loop for retries        */
        {
                while( rxstat() )
                        rx();
                i = 0;           /* retry count                  */
                while( TRUE )
                {
                        printf( "\nWaiting for filename request");
                        if( waitcan( RETRY ) == NAK )
                                break;
                        if( i++ ) RETRY )
```

```
                        error( "Can't send filename" );
                    printf( " - Received garbage" );
                }
                tx( ACK );          /* handshake name request        */
                sleep();            /* decent interval               */
                printf( "\nSending name: " );
                clrcrc();           /* clear checksum accumulator    */
                for( i = 0 ; i < NAMESIZE ; i++ )/* name loop        */
                {
                        tx( name[ i ] );
                        putchar( name[ i ] );   /* local echo        */
                        wait( 10 );     /* wait for ACK              */
                }
                tx( EoF );              /* name terminated w/EoF*/
                if( wait( 10 ) == checksum )    /* handshake     */
                {
                        printf( " - Name sent OK" );
                        tx( ACK );      /* handshake OK checksum*/
                        crc = crcsav;   /* replacce 'crc'        */
                        return;         /* normal exit           */
                }
                tx( BADNAME );          /* handshake bad chksm   */
                printf( " - Bad name transfer" );
        }
}


/*-----------------------------------------------------------------
txrec() transmits a single record, with retransmit on error from
receiver. Input is a pointer to the I/O buffer.

References globals: rec, crcaccum, checsum, crc;
Modifies globals: rec;
-----------------------------------------------------------------*/

VOID txrec( buf )
   char *buf;
{
   register int i;
   unsigned cr;

        while( TRUE )                   /* do it until right     */
        {
                printf( "\rTransmitting record %d   ", rec );
                tx( SOH );              /* start of header       */
                tx( rec );              /* rec #                 */
                tx( ~rec );             /* 1's comp              */
                clrcrc();               /* clear CRC accum       */
                for( i = 0 ; i < RECSIZE ; i++ )
                        tx( buf[ i ] ); /* send record           */
                updcrc( 0 );            /* finish up CRC         */
                updcrc( 0 );            /* again                 */
                cr = crcaccum;          /* save crc lobyte       */
                if( crc )               /* send hi byte first    */
                {
                        tx( crcaccum >> 8 );
                        tx( cr );
                }
                else
                        tx( checksum );
                if( waitcan(10)==ACK )  /* quit if correct       */
                        break;
                printf( "Error in transmission\n" );
        }
        rec++;                          /* bump record count     */
}


/*-----------------------------------------------------------------
receive() is the receive executive. It requires no input
parameters except 'crc' should be set. Does not "hunt" from
CRC to checksum.

References globals: line;
Modifies globals: line;
-----------------------------------------------------------------*/

VOID receive()
{
        printf( "\n\nReceive File specification: " );
        gets( line );
        if( rxstat() )
                rx();                   /* gobble trash          */
        if( index( line, '*' ) != NULL )/* 'batch' set by a      */
                rxbatch( line );        /* asterisk              */
                                        /* in input file name    */
        else
                rxfile( line );         /* otherwise nobatch     */
}
```

(Continued on next page)

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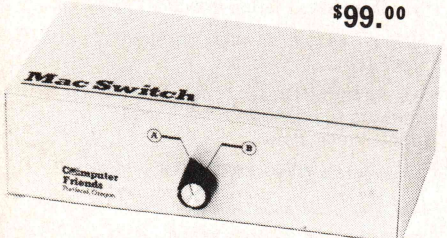

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Protocols Listing

(Listing continued, text begins on page 66)

```
/*-----------------------------------------------------------------
rxbatch() is the batch mode reception executive.

References Globals: line;
Modifies Globals: line;
-----------------------------------------------------------------*/

VOID rxbatch()
{
    char fcb[ NAMESIZE + 1 ];     /* used by unparse()            */
    char name[ NAMESIZE + 5];     /* unparsed name                */

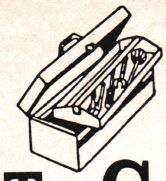
        while( TRUE )
        {
                while( rxstat() )         /* gobble trash         */
                        rx();
                printf( "\nWaiting for file name:  " );
                rxname( fcb );  /* receive file name into fcb     */
                unparse( name, fcb );    /* make "standard"       */
                if( line[ 1 ] == ':' )
                        line[ 2 ] = '\0';
                else
                        line[ 0 ] = '\0';
                strcat( line, name );
                rxfile( line );           /* receive file         */
        }
}


/*-----------------------------------------------------------------
rxname() loads a CP/M style fcb with a filename from remote
sender. On receipt of an EOT instead of a name character,
aborts to master menu via longjmp().
-----------------------------------------------------------------*/

VOID rxname( fcb )
   char *fcb;                     /* points to CP/M style fcb     */
{
   char *fcbptr;                  /* index to fcb                 */
   register int i;                /* scratch counter              */
   int ch;                        /* scratch char (must hold ERR) */
   char chksum;                   /* checksum accumulator         */

        while( TRUE )
        {
                fcbptr = fcb;             /* align index          */
                i = RETRY * 5;            /* retry for name h.s.  */
                while( TRUE )             /* Handshake NAK        */
                {
                        abort();          /* check operator abort */
                        tx( NAK );
                        if( swait() == ACK )
                                break;
                        if( !( i-- ) )
                                error( "Timed out waiting for name" );
                }
                chksum = EoF;             /* init checksum        */
                for( i = 0 ; i < 34 ; i++ )     /* accept noise   */
                {
                        if( (ch = swait()) == EOT )
                        {
                                tx( ACK );
                                printf(
                                "\nAll transfers completed" );
                                longjmp( &to_menu, 0 );
                        }
                        if( ch == EoF ) /* End of name chars      */
                                break;
                        if( ch != ERROR )         /* not timeout  */
                        {
                                *(fcbptr++) = ch & 0x7F;
                                putchar( ch );
                                chksum += ch & 0x7F;
                        }
                        abort();          /* operator abort       */
                        tx( ACK );        /* handshake name char  */
                }
                fcb[ NAMESIZE ] = 0;      /* terminate name field */
                do {
                        abort();          /* operator abort       */
                        tx( chksum );     /* handshake checksum   */
                } while( (ch = swait()) == ERROR );
```

(Continued on page 80)



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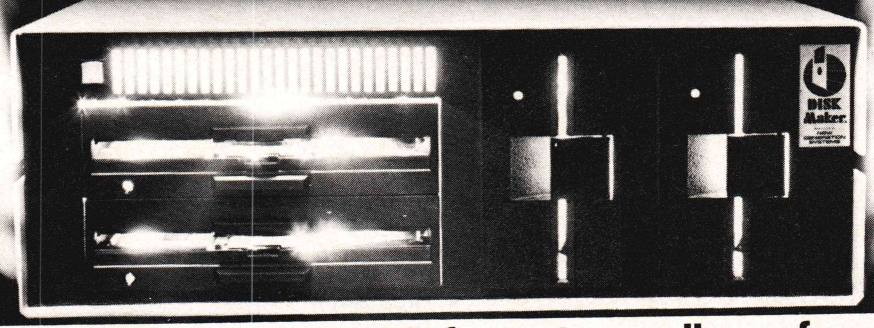

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```
            if( ch == ACK )          /* ACK is good name      */
                    return;
            printf(" - Checksum error\nRetrying file name: " );
        }
}


/*---------------------------------------------------------------
rxfile() receives a file. Input parameter is the name, including
drivspec if any, to save incoming data under. To maintain speed
the function is rather long to reduce function calls where
possible. Have 'crc' set before entry.

References globals: buffer, fd, rec, crcaccum, checksum, crc;
Modifies globals: buffer, rec;
---------------------------------------------------------------*/

VOID rxfile( name )
   char *name;
{
   char ch;                      /* scratch handshake var        */
   char response;                /* ACK/NAK/CRC handshake        */
   char crcrlo;                  /* rec'd CRC low byte           */
   char crcrhi;                  /* rec'd CRC hi byte            */
   char r1;                      /* current record number        */
   char r2;                      /* 1's comp record number       */
   unsigned int j;               /* wait loop timer              */
   int i;                        /* scratch counter              */
   register char *bptr;          /* buffer index                 */

        while( rxstat() )
                rx();

        make( name );            /* open/make backup             */
        printf( "\n" );
        rec = 1;                 /* uses natural numbering       */
        if( crc )                /* set initial handshake to     */
                response = CRC; /* CRC or checksum               */
        else
                response = NAK;
        while( TRUE )            /* record receive loop          */
        {
                bptr = buffer;           /* align index          */
                printf( "\rWaiting for record %d       ", rec );
                for( i=1 ; i <= RETRY * 5 ; i++ )
                {
                        abort();
                        tx( response ); /* send handshake        */
                        if( (ch = swait()) == SOH )
                                break;  /* SOH indicatees rec    */
                        if( ch == EOT ) /* EOT indicates done    */
                        {
                                printf( "\n%s received OK", name );
                                fclose( fd );
                                tx( ACK );       /* handshake    */
                                return;          /* normal exit  */
                        }
                        if( ch == CAN ) /* Xmit request abort    */
                        {
                                fclose( fd );
                                error("\rReceived cancel request");
                        }
                        if( i == RETRY * 5 )     /* timeout exit */
                                error( "Can't sync to sender" );
                }
                r1 = swait();            /* record number        */
                r2 = swait();            /* 1's comp record #    */
                while( bptr - buffer < RECSIZE ) /* test count   */
                {
                        *(bptr++) = swait();     /* accept char  */
                }
                if( crc )                /* get hibyte CRC       */
                        crcrhi = swait();
                crcrlo = swait();        /* lobyte CRC or chksm  */
                response = NAK;          /* init response        */
                if( (~r1 & 0xFF) != (r2 & 0xFF) )
                {
                        printf( "- Record numbers don't match\n" );
                        continue;
                }
                clrcrc();                /* calc checksum/CRC    */
                for( j = 0 ; j < RECSIZE ; j++ )
                        updcrc( buffer[ j ] );
```

(Continued on page 82)

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```
                updcrc( 0 );                    /* required to finish   */
                updcrc( 0 );                    /* off CRC - why?       */
                if( crc )                       /* CRC test             */
                        if( (crcrlo + (crcrhi (( 8)) != crcaccum )
                        {

                                printf( "- Bad CRC received\n" );
                                continue;
                        }
                if( !crc )                      /* checksum test        */
                        if( crcrlo != checksum )
                        {
                                printf("- Bad checksum received\n");
                                continue;
                        }
                if( (rl == (rec - 1) & 0xFF ) ) /* duplicate?           */
                {
                        printf( " - Received duplicate record\n" );
                        response = ACK; /* dup is OK - ACK was  */
                        continue;       /* trashed - ignore it  */
                }
                if( rl != (rec & 0xFF) )/* fatal sequence error */
                        error( "File record numbering error" );
                rec++;                          /* bump record count    */
                for( j = 0 ; j ( RECSIZE ; j++ ) /* write data  */
                        putc( buffer[ j ], fd );
                response = ACK;                 /* normal loop end      */
        }
}


/*-----------------------------------------------------------------
make() opens a file for output. It renames any existing file
with the same name to ".BAK", and erases any previous backup.
Input parameter is filespec in "normal" (compressed) format.
Note: file rename by the link() function isn't supported
by several CP/M C Compilers, and others call this function
rename(), or reverse the arguments. At any rate, you can determine
how to handle backups in your own system and take any
appropriate action.

References globals: fd;
Modifies globals: fd;
-----------------------------------------------------------------*/

VOID make( name )
   char *name;
{
#ifdef LINK
   char bak[ NAMESIZE + 5 ];    /* holds .BAK filespec          */

                                /* does this name exist?        */
        if( (fd = fopen( name, "r" )) != NULL )
        {
                fclose( fd );   /* we were just checking        */
                strcpy( bak, name );    /* save old name        */
                if( index( name, '.' ) )/* extension spec'ed?   */
                        strcpy( index( bak, '.' ), ".BAK" );
                else
                        strcat( bak, ".BAK" );
                unlink( bak );  /* dump any old .BAK file       */

                link( bak, name ); /* rename new .BAK file      */
        }
#endif
        if( (fd = fopen( name, "wb" )) == NULL )
                error( "Can't create file - Aborting" );
}


/*-----------------------------------------------------------------
parse() expands  non - ambiguous filespecs to the
standard CP/M fcb format, excluding drive byte.
Sets the globals
'batch' if ambigous, and 'driv' for drivespecs.
Inputs are "normal" filespec (inspec), and exanded fcb.
-----------------------------------------------------------------*/

char *parse( inspec, fcb )
   char *inspec, *fcb;
{
   register int i;                      /* fcb index            */
   int inptr;                           /* input spec index     */
```

(Continued on page 84)

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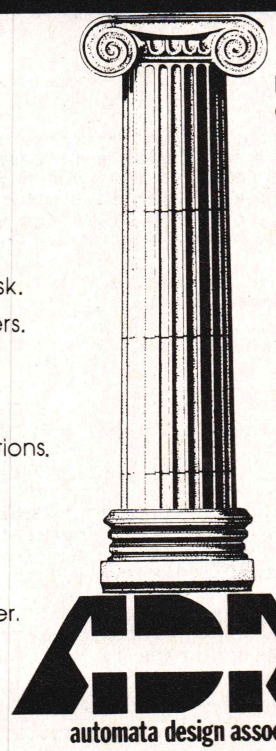

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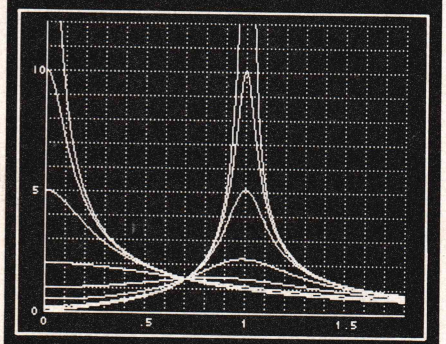

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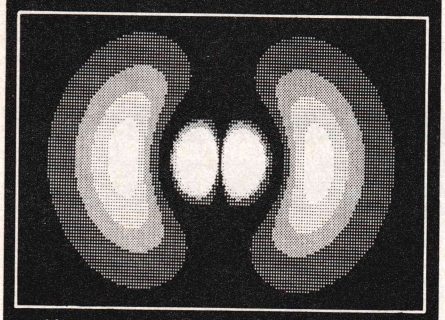

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Protocols Listing

(Listing continued, text begins on page 66)

```
        for( i = 0 ; i ( NAMESIZE ; i++ )/* blank fill name      */
                fcb[ i ] = ' ';
        if( inspec[ 1 ] == ':' )          /* check for drivspec   */
                inptr = 2;                /* point past drivespec */
        else
                inptr = 0;                /* index to start       */
        i = 0;                            /* pointer into fcb     */
        while( TRUE )
                switch( inspec[ inptr++ ] )
                {
                        case '\0':        /* end of input spec    */
                                fcb[ NAMESIZE ] = 0;
                                return( fcb );
                        case '.':         /* extension spec'ed    */
                                i = NAMESIZE - 3; /* extension  */
                                break;
                        default:
                                if( i ( NAMESIZE )
                                        fcb[ i++ ] = toupper(
                                        inspec[ inptr - 1 ] );
                }
}


/*-----------------------------------------------------------------
fillbuf() loads the I/O buffer with a record from the input file.
Returns TRUE if data was available, FALSE if no data left.

References globals: buffer, fd;
Modifies globals: buffer;
-----------------------------------------------------------------*/

int fillbuf()

{
   register int i;                /* scratch counter              */
   int errorchk;                  /* holds EOF in Eco C           */

        for( i = 0 ; i ( RECSIZE ; i++ )
        {
                if( (errorchk = getc( fd)) == EOF )
                        break;
                buffer[ i ] = errorchk;
        }
        if( i == 0 )                          /* no data read     */
                return( FALSE );
        for( ; i ( RECSIZE ; i++ )
                buffer[ i ] = 0;              /* zero fill at EOF */
        return( TRUE );
}


/*-----------------------------------------------------------------
unparse() reassembles a filename from a CP/M fcb into "normal" or
cmpressed form, so that our C functions can deal with them.
Inputs are a pointer to a string to receive the name (name), and
a pointer to a CP/M style fcb entry (buf).
-----------------------------------------------------------------*/

char *unparse( name, buf )
   char *name, *buf;
{
   register int i;                /* 'name' index                 */
   int j;                         /* 'buf' index                  */

        i = 0;                    /* 'driveless' name     */
        for( j = 0 ; j ( NAMESIZE ; j++ )/* transfer chars       */
        {
                if( buf[ j ] != ' ' )   /* (skip spaces)          */
                        name[ i++ ] = buf[ j ] & 0x7F;
                if( j == NAMESIZE-3 )   /* don't forget dot       */
                        name[ i++ ] = '.';
        }
        name[ i ] = '\0';                     /* terminate string */
                                              /* eat terminal dot */
        if( *(index( name, '.' ) + 1) == '\0' )
                *(index( name, '.' )) = '\0';
        return( name );                       /* return pointer   */
}


/*-----------------------------------------------------------------
clrcrc() clears the crc accumulator. Not much to it, actually.
```

(Continued on page 86)

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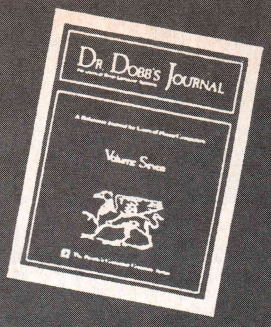

Vol. 7 1982

In 1982 we introduced several significant pieces of software, including the RED text editor and the Runic extensible compiler, and we continued to publish utility programs and useful algorithms. Two new columns, The CP/M Exchange and The 16-Bit Software Toolbox, were launched, and we devoted special issues to FORTH and telecommunications. Resident Intern Dave Cortesi supplied a year of "Clinic" columns while delivering his famous review of JRT Pascal and writing the first serious technical comparison of CP/M-86 and MSDOS. This was also the year we began looking forward to today's generation of microprocessors and operating systems, publishing software for the Motorola 68000 and the Zilog Z8000 as well as Unix code. And in December, we looked beyond, in the provocative essay, "Fifth-generation Computers."

Vol. 1 1976

The material brought together in this volume chronicles the development in 1976 of Tiny BASIC as an alternative to the "finger blistering," front-panel, machine-language programming which was then the only way to do things. This is always pertinent for bit crunching and byte saving, language design theory, home-brew computer construction and the technical history of personal computing.

Topics include: Tiny BASIC, the (very) first word on CP/M, Speech Synthesis, Floating Point Routines, Timer Routines, Building an IMSAI, and more.

Vol. 2 1977

1977 found **DDJ** still on the forefront. These issues offer refinements of Tiny BASIC, plus then state-of-the-art utilities, the advent of PILOT for microcomputers and a great deal of material centering around the Intel 8080, including a complete operating system. Products just becoming available for reviews were the H-8, KIM-1, MITS BASIC, Poly Basic, and NIBL.

Articles are about Lawrence Livermore Lab's BASIC, Alpha-Micro, String Handling, Cyphers, High Speed Interaction, I/O, Tiny Pilot & Turtle Graphics, many utilities, and even more.

Vol. 3 1978

The microcomputer industry entered its adolescence in 1978. This volume brings together the issues which began dealing with the 6502, with mass-market machines and languages to match. The authors began speaking more in terms of technique, rather than of specific implementations; because of this, they were able to continue laying the groundwork industry would follow. These articles relate very closely to what is generally available today.

Languages covered in depth were SAM76, Pilot, Pascal, and Lisp, in addition to RAM Testers, S-100 Bus Standard Proposal, Disassemblers, Editors, and much, much more.

Vol. 4 1979

This volume heralds a wider interest in telecommunications, in algorithms, and in faster, more powerful utilities and languages. Innovation is still present in every page, and more attention is paid to the best ways to use the processors which have proven longevity—primarily the 8080/Z80, 6502, and 6800. The subject matter is invaluable both as a learning tool and as a frequent source of reference.

Main subjects include: Programming Problems/Solutions, Pascal, Information Network Proposal, Floating Point Arithmetic, 8-bit to 16-bit Conversion, Pseudo-random Sequences, and Interfacing a Micro to a Mainframe—more than ever!

Vol. 5 1980

All the ground-breaking issues from 1980 in one volume! Systems software reached a new level with the advent of CP/M, chronicled herein by Gary Kildall and others (**DDJ's** all-CP/M issue sold out within weeks of publication). Software portability became a topic of greater import, and **DDJ** published Ron Cain's immediately famous Small-C compiler—reprinted here in full!

Contents include: The Evolution of CP/M, a CP/M-Flavored C Inerpreter, Ron Cain's C Compiler for the 8080, Further with Tiny BASIC, a Syntax-Oriented Compiler Writing Language, CP/M to UCSD Pascal File Conversion, Run-time Library for the Small-C Compiler and, as always, even more!

Vol. 6 1981

1981 saw our first all-FORTH issue (now sold out), along with continuing coverage of CP/M, small-C, telecommunications, and new languages. Dave Cortesi opened "Dr. Dobb's Clinic" in 1981, beginning one of the magazine's most popular features.

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Protocols Listing

(Listing continued, text begins on page 66)

```
References globals:
Modifies globals: crcaccum, checksum;
-----------------------------------------------------------------*/

VOID clrcrc()

{
        crcaccum =
        checksum = 0;
}

/*-----------------------------------------------------------------
updcrc() updates the crc accumulator, if 'crc' is TRUE, else
updates the checksum.
'x' is the byte to be added to CRC or checksum.
CCITT polynomial.

References globals: crc;
Modifies globals: crcaccum, checksum;
-----------------------------------------------------------------*/

VOID updcrc( x )
   char x;
{
   unsigned shifter, i, flag;

        if( crc )
        {
                for( shifter = 0x80 ; shifter ; shifter >>= 1 )
                {
                        flag = (crcaccum & 0x8000);
                        crcaccum <<= 1;
                        crcaccum |= ((shifter & x) ? 1 : 0);
                        if( flag )
                                crcaccum ^= 0x1021;
                }
        }
        else
                checksum += x;
}


/*-----------------------------------------------------------------
abort() scans console for ^X abort code. Exit via error().
System Dependent. If not supportable, convert to null function
or delete and use a preprocessor macro to make it go away.
-----------------------------------------------------------------*/

VOID abort()
{
        if( _bdos( 6, 0xFF ) == 'X'-'@' )
                error( "\rOperator requested abort" );
}


/*-----------------------------------------------------------------
error() does error abort cleanup

References globals: fd;
-----------------------------------------------------------------*/

VOID error( str )
   char *str;
{
        fclose( fd );                   /* dump any open files  */
        tx( CAN );                      /* alert remote         */
        putchar( BELL );                /* alert operator       */
        printf("\n\nError - %s\nPress any key to continue", str );
        getchar();                      /* pause                */
        longjmp( &to_menu, 0 );         /* rejoin menu          */
}


/*-----------------------------------------------------------------
sleep() does a short delay to account for transmission line
latency, etc.
-----------------------------------------------------------------*/

VOID sleep()
{
   register unsigned int i;

        for( i=0 ; i < MAGIC_NUMBER ; i++ )
                ;
}
```

(Continued on page 88)

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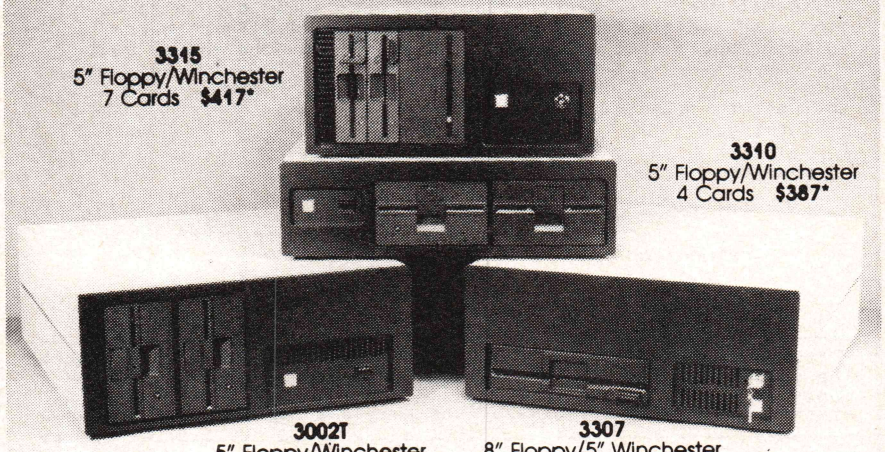

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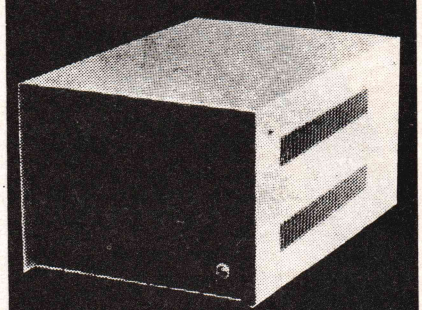

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Protocols Listing

(Listing continued, text begins on page 66)

```
/*-------------------------------------------------------------
wait() waits for a character - timeout built in. Timeout
condition causes error return to menu.
Input parameter 'time' controls duration of wait.
-------------------------------------------------------------*/

int wait( time )
   int time;
{
   register unsigned int i;              /* loop timer          */
   int j;                                /* timeout count       */

        j =                              /* timeout count       */
        i = 0;                           /* inner timeout count */
        while( !rxstat() )
                if( i++ ) MAGIC_NUMBER * 3 )/* about 1.5 secs   */
                        if( !(time--) ) /* check retry count   */
                                error( "Receiver timed out" );
                        else             /* more tries available */
                        {
                                abort(); /* scan for ^X         */
                                if( !j ) /* \n first timeout    */
                                        printf( "\n" );
                                printf( "\rtimeout %d   ", ++j );
                                i = 0;
                        }
        return( rx() );                  /* send back char      */
}

/*-------------------------------------------------------------
swait() does a short wait for a char from rx, returns ERROR on
a timeout, or char received.
-------------------------------------------------------------*/

int swait()
{
   register unsigned int i;              /* loop timer          */

        i = 0;
        while( i++ < MAGIC_NUMBER )      /* loop timing test    */
                if( rxstat() )           /* anything yet?       */
                        return( rx() ); /* yes, return char    */
        return( ERROR );                 /* timeout exit        */
}


/*-------------------------------------------------------------
waitcan() waits for a character - If recv's CAN aborts to main
menu. Uses wait() for timing loop, so timeout also returns
to main menu. Input argument 'time' controls duration of wait.
-------------------------------------------------------------*/

int waitcan( time )
   int time;
{
   char ch;

        if( (ch = wait( time )) == CAN )
                error( "Received cancellation request" );
        return( ch );
}


/*-------------------------------------------------------------
=============================================================
The following functions are machine dependant and should be
modified to run on your machine.
=============================================================
-------------------------------------------------------------*/


/*-------------------------------------------------------------
init() initializes globals. In addition, UART initialization
goes here as well, if required. No input parameters. May have
some machine dependant stuff here.

References globals:
Modifies globals: crc, batch, buffer, line;
-------------------------------------------------------------*/

VOID init()
{
        buffer = alloc( RECSIZE );       /* transfer buffer     */
```

```
        line = alloc( 81 );             /* scatch input line    */
        crc =                           /* CRC mode             */
        batch = TRUE;                   /* not really required  */
}


/*-----------------------------------------------------------------
rx() receives a char from uart. No timeout checking is performed.
Also, no status check is done. Bad news if you call this without
checking status first... Done that way to speed up things.

                        ZORBA Version
-----------------------------------------------------------------*/

int rx()
{
        return( inp( RXDATA ) );
}


/*-----------------------------------------------------------------
rxstat() returns TRUE if char waiting for input.

              ZORBA Version (interrupt fifo)
-----------------------------------------------------------------*/

int rxstat()
{
        return( inp( UARTCMD ) & 2 );
}


/*-----------------------------------------------------------------
tx( ch ) transmits the char 'ch', and calls the CRC/checksum
update. A timeout is built in for transmission faults.

                        ZORBA Version
-----------------------------------------------------------------*/

VOID tx( ch )
   char ch;
{

   register unsigned int i;             /* timing loop counter  */

        i = 0;
        while( !txstat() )              /* ready?               */
                if( i++ > MAGIC_NUMBER )/* loop about 3 secs    */
                        error( "UART not ready??" );
        outp( TXDATA, ch );             /* to UART              */
        updcrc( ch );                   /* stir CRC a little    */
}


/*-----------------------------------------------------------------

txstat() returns TRUE if tx register is empty

                        ZORBA Version
-----------------------------------------------------------------*/

int txstat()
{
        return( inp( UARTCMD ) & 4 );
}


/*-----------------------------------------------------------------
quit() does exit processing.
-----------------------------------------------------------------*/

VOID quit()
{
        exit( 0 );
}
```

End Listing

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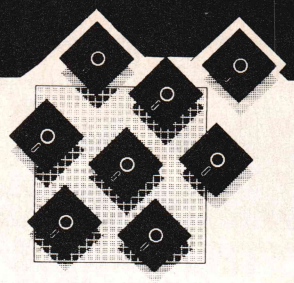

Envoy, Version 1.1

Company: Artisoft Inc., 2450 E. Speedway, Suite 4, Tucson, AZ 85719 (602) 327-4305
Computer: IBM PC family, 16-bit compatibles, 8-bit CP/M
Price: $49.95
Circle Reader Service No. 144
Reviewed by David W. Carroll

The trend in microcomputer software is toward high-volume, high-quality, low-cost software (under $100). Borland International pioneered this "volks-software" concept with Turbo Pascal and Sidekick, and other companies are now following this path.

Commercial telecommunications software typically costs $200 and more, but Artisoft of Tucson, is now offering its Envoy communications package with versions that run on almost any microcomputer system for only $49.95.

"With over a dozen major commercial programs available, who needs another?" you might well ask. First, the price of Envoy represents a breakthrough. Second, the program is small, fast, and easy to use. Third, Envoy offers some unique features. Finally, compatible versions are available for almost any type of microcomputer and operating system.

Operation

Envoy is a menu-driven communications program. This means that it has two modes: command and terminal. In command mode, the current menu is shown on the screen. In terminal mode, you are on line with your serial port or modem, and Envoy is transparent to all keyboard input except for your terminal mode "exit" character, usually escape <Esc>. Envoy requires you to set your terminal mode exit character when you start each session. The program's main menu appears below:

```
*** Main Menu ***

<T>   — Smart Terminal
<E>   — ENVOY file transfers
<X>   — XMODEM file transfers
<P>   — Port Parameters
<U>   — Utilities
<Ret> — Previous menu
<Esc> — Exits ENVOY

Enter your selection –>
```

The program offers dumb terminal operation, ASCII file send and buffer capture, and protocol file transfers. Envoy supports both the Ward Christensen XMODEM protocol and the little known ANSI standard X3.28 file transfer protocol.

The ANSI protocol is designed so that either computer in a data link can act as master while the other is a slave. This allows multiple file transfers and remote system utility operation (you can use the remote system's utility menu). The transfer protocol is faster than XMODEM and provides greater error checking.

This menu appears when you select Smart Terminal:

```
*** Smart Terminal ***

Capture Buffer is Off

<T>   — Terminal Mode
<S>   — Send Text File
<M>   — Modem Functions
<O>   — Terminal Mode Options
<C>   — Capture Buffer On
<B>   — Buffer Utilization
<W>   — Write Buffer to Disk
<D>   — Display Buffer
<U>   — Utilities
<Ret> — Previous menu
<Esc> — Exits ENVOY

Enter your selection –> B

Capture Buffer 57362 bytes
Remaining Space 57362 bytes

[Enter any key to continue]
```

Envoy uses an autodial menu and even supports simple "script" files for autologon. It will support almost any modem because of its free-form modem command/phone number directory. The directory consists of a file with entries created using a word processor or editor (like WordStar or EDLIN). A few typical directory entries for a Hayes Smartmodem follow:

```
Redial [A/|]
Disconnect [_+++_ATH0]
Information [ATDT1-555-1212]
```

Here is a sample directory listing:

```
*** Modem Functions ***

<A>   — Redial
<B>   — Disconnect
<C>   — Information
<D>   — ARTISOFT, Inc.
<E>   — CompuServe
<Ret> — Previous menu
<Esc> — Exits ENVOY

Enter your selection –>
```

Envoy scripts can include keyboard control characters, delays, and character-matching strings. The special characters ^, _, and | provide these features when inserted in script entries. Question marks indicate strings to match.

You can set the terminal mode

Copyright by David W. Carroll

communications parameters, which include stripping line feeds, local echo mode, and delay of up to 9 sec between each line sent for ASCII text file transfers:

*** Terminal Mode Options ***

<L> — Send LFs On
<D> — Delay Lines (0)
<E> — Local Echo On
<X> — Change Exit Key
<Ret> — Previous menu
<Esc> — Exits ENVOY

Enter your selection –>

You may also set port parameters (speed, parity, etc.) from within Envoy.

Full operating system utilities are available from within Envoy, and PC/MSDOS users have full access to DOS 2.0 subdirectory commands and paths. The program even supports remote system operation (unattended). This menu is for the IBM PC version of Envoy PC:

*** Utilities ***

<D> — Directory
<L> — Log to another disk
<E> — Erase files
<T> — Type files
<C> — Copy a file
<R> — Rename a file
<P> — Print files
<N> — Change directory path
<S> — Create a directory path
<X> — Remove a directory path
<Ret> — Previous menu
<Esc> — Exits ENVOY

Enter your selection –>

Envoy is written in assembly code; that means it is fast and compact. The program takes a total of 7–9K disk space, depending on the version. That is small enough to put on every floppy—not much more space than the old standby MODEM7 program requires—and Envoy offers many more features.

Evaluation

Envoy PC operates reliably in all modes. My only complaints were regarding the effort required to make new directory entries. I found it clumsy to exit the program, start up a word processor, and enter numbers in the directory file. The lack of a real-time directory entry mode, similar to what Crosstalk and Smartcom II offer, was irritating. I also didn't like to reenter the required modem commands in each directory entry, though this is a minor point.

Overall, the Envoy communications programs are well designed, easy to use, and versatile. For a reasonable price, they provide virtually every communications feature you could require.

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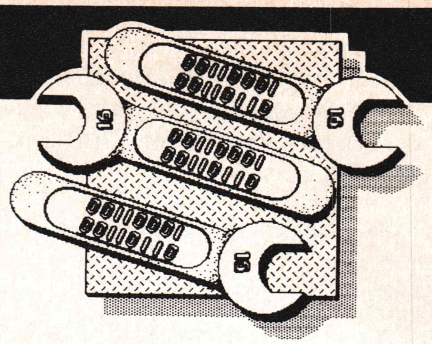

by Ray Duncan

IBM PC WordStar and the HP LaserJet

We at Laboratory Microsystems recently purchased an HP LaserJet printer to produce our various software manuals. After buying the LaserJet, we were dismayed to find that it is essentially impossible to configure IBM PC WordStar to properly use the printer's boldface, italics, and various fonts. WordStar allows the user to patch in only four-character escape sequences, while nearly every important LaserJet control sequence is five bytes or longer. When we contacted the HP dealer about this problem, his response was, "Well, you'll just have to switch to Spellbinder; it supports all the LaserJet capabilities."

Because we have around 10 Mb of documentation files that we would have to convert if we switched word processors, this option didn't sound too attractive. My first attempt at getting around the problem was to write a character filter that read a WordStar document file, translated the various control codes (such as ^B) into the proper LaserJet escape sequences, and sent the result to the printer. This worked acceptably as far as print quality, but it required an exit from WordStar whenever you wanted to print something, which made WordStar's capability of background printing while editing useless.

It began to look as if we would have to face the facts and do some heavy-duty disassembly and patching of WordStar. On a long shot, I dropped a note to MicroPro Technical Support, asking them if they knew of anyone who had already worked out the necessary patches. Much to my amazement, I got an immediate phone call from a nice lady at MicroPro who said that a LaserJet version of WordStar was already available to licensed users for $25.00. I duly sent off my check and in a few days received a diskette containing a new WS.OVL file and a batch file that performs some patches to the WS.COM file.

After following the installation steps in the accompanying documentation, I ended up with a WordStar that supports italics, boldface, double-strike, underline, over-strike, micro-justification, superscripting, subscripting, variable character pitch, variable line height, and multiple copies on the HP LaserJet. It's a little slow (only 2–3 pages/min throughput) and has a few bugs (a ^Y at the start of a line makes it go crazy), but it works pretty well. You can get this enhancement disk by sending a polite letter, including your WordStar version 3.3 serial number and $25.00, to LaserJet Technical Support, MicroPro International Corp., 33 San Pablo Ave., San Rafael, CA 94903.

Microsoft 8086 MacroAssembler 2.0

Many moons after Microsoft announced version 2.0 of the 8086 MacroAssembler, it has appeared in the IBM Product Centers in the last few weeks without fanfare. Along with the new, higher version number comes a new, higher price ($175.00). Silly me. I thought that because I had bought version 1 with its zillions of bugs I might be entitled to a reduced cost update, but the Product Center salesman nearly killed himself laughing when I brought *that* up. Finally, gritting my teeth and hoping that the new version would be a little more robust than the old, I hauled out my well-worn MasterCard and took home a copy.

If you choose to go the same route, what will you get for your money? Well, the first thing you get is a MacroAssembler that has an even more severe case of bloat than the first version (the EXE file is 76,544 bytes compared to 67,584 bytes for version 1). The 8087 mnemonics are now fully supported, along with most of the additional 80286 mnemonics that would be used in that CPU's real mode. The performance of the MacroAssembler has improved considerably: a 106K source file (approximately 3200 lines), which required 13 min 57 sec to assemble with version 1, is assembled in 4 min 13 sec with version 2.

Version 2 provides a new version of the Linker (which has also suffered more bloat to the tune of about 6K), a documented Library manager, and a new program called SALUT (Structured Assembly Language Utility), which converts an assembly language source file containing high-level control structures into a source file that can be fed to the assembler. Although IBM pushes SALUT pretty hard in the MacroAssembler manual, I see no evidence in the BIOS listings or distributed PCDOS assembler source files (such as VDISK.ASM) that IBM programmers ever use it. Perhaps IBM is adopting some of Apple's policies for "the rest of us."

The manual for the MacroAssembler has been drastically overhauled. The previous "encyclopedia" format, which devoted a page to each of the assembler directives and 8086 mnemonics with examples, has been abandoned. The new manual is heavily oriented to *operation* of the assembler and associated utilities (everything is called "sessions" now) and provides almost no programming guidance whatsoever. A copy of Rector and Alexy's *The 8086 Book* or the Intel *iAPX 86 User's Manual* will be

indispensable to people who start out with the new MacroAssembler and no previous experience.

Some of the known bugs in version 1 appear to have been fixed; these include the operand order in the SHL and SHR operators, the XOR that used to work like OR, the packed decimal data generated by the DT pseudo-op, the failure of DUP to work properly inside the invocation of a STRUC, and the lack of error messages and generation of "funny" opcodes for some nonexistent instructions (such as CMP ES,0). Error detection (and the quality of the error messages) seems generally improved.

Some bugs, however, remain. I've provided a few examples in Listing Two (page 104). A major problem seems to be inconsistent handling of signed and unsigned values by the logical operators. This is "explained" to some extent by a comment in the manual on page 2-28: "When relational operators are used, results are produced by comparing 17-bit signed numbers, where the 17th bit can contain only a sign bit." This accounts for the behavior of the LT and GT operators, but if it were strictly true, the expression "–1 EQ 0FFFFH" would return a false flag (which it doesn't, as you can see by the listing). Anyway, it's a mystery to me why Microsoft thought it should support within expressions a 17-bit data type that has no physical equivalent in the 8086 processor family. Wouldn't it make more sense to have the assembler evaluate expressions to the same results that you would get with in-line machine code?

The TRIM Filter

In the last few months, we have printed three new "filters" for MSDOS: CLEAN, TEE, and TK. In this month's column, we print another filter, named TRIM, contributed by A. K. Head of Melbourne, Australia (Listing One, page 96). I have taken the liberty of retyping and reformatting the program from his original listing, and I have added some error messages; hence, credit for the concept and implementation should go to Mr. Head, while blame for any bugs or other deficiencies specially introduced by publication in *DDJ* is mine.

In spite of its brevity, TRIM is a fairly sophisticated filter that can perform one of several operations:

- Exclude all the characters *outside* a given range of columns from each line of a file
- Exclude all the characters *inside* a given range of columns from each line of a file
- Delete trailing blanks from each line of a file
- Delete blank lines from a file

Documentation for the use of TRIM appears in the beginning of the source listing itself. You can use TRIM in combination with SORT and various other commands by means of the Unix-like pipes of MSDOS 2.x to perform complex operations. For example, the following command line will isolate the filename and extension from each line of a directory listing, sort the list, and leave the result

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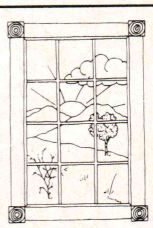

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in a file named SORTED.DIR:

```
A>DIR¦TRIM 1,12¦SORT
    >SORTED.DIR
```

Incidentally, you can download the source for all the programs printed in this column, as well as many other useful MSDOS utilities, from the Laboratory Microsystems Bulletin Board System at (213) 306-3530 (300 or 1200 baud). This BBS is up between 6 PM and 9 AM, Pacific Time, on weekdays and for 24 hours on weekends and holidays. **DDJ**

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16-Bit Toolbox (Text begins on page 94)

Listing One

```
        name    trim
        page    55,132
        title   'TRIM - excerpt lines of a file'
;
; TRIM --- excerpts selected columns from each line
;          of a file and writes them to the selected
;          output device or file.
;
; A "filter" for MS-DOS or PC-DOS version 2 or higher,
; after the fashion of Unix.   Reads from the standard input
; (redirectable) and writes to the standard output (redirectable).
; Error messages are directed to the standard error device.
;
; TRIM can be (and usually would be) used in a pipe, e.g.
;
;    | TRIM 7,45 |
;
; transmits only the characters in columns 7 to 45 (inclusive)
; of each line.  A minus sign reverses the action, e.g.
;
;    | TRIM -7,45 |
;
; transmits all characters except those in columns 7 to 45.
;
; Special actions:
;
;    | TRIM 0  |        deletes trailing spaces from lines, and
;    | TRIM -0 |        also discards empty lines
;
; By A. K. Head, 6 Duffryn Place, Melbourne, Australia 3142
; reformatted and error handling added by Ray Duncan
;

command equ     80h             ; buffer for command tail
fcb1    equ     5ch             ; default file control block #1
fcb2    equ     6ch             ; default file control block #2

buflen  equ     16384           ; buffer length, alter to taste

cr      equ     0dh             ; ASCII carriage return
lf      equ     0ah             ; ASCII line feed
ff      equ     0ch             ; ASCII form feed
eof     equ     01ah            ; End-of-file marker
tab     equ     09h             ; ASCII tab code
blank   equ     20h             ; ASCII blank

                                ; DOS 2.x pre-defined handles
stdin   equ     0000            ; standard input file
stdout  equ     0001            ; standard output file
stderr  equ     0002            ; standard error file
stdaux  equ     0003            ; standard auxilliary file
stdprn  equ     0004            ; standard printer file

cseg    segment para public 'CODE'
```

(Continued on page 98)

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Listing One

```
        assume  cs:cseg,ds:cseg

        org     100H                ; start .COM at 100H

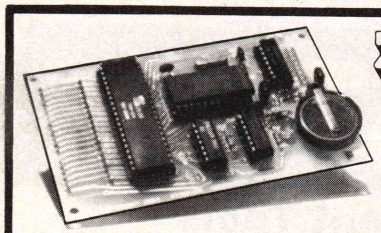
start:  jmp     near ptr trim

param1  dw      0                   ; command parameter #1
param2  dw      0                   ; command parameter #2
sign    dw      0                   ; nonzero if "-" in command
count   dw      0                   ; column count, current line
topin   dw      0                   ; chars in input buffer - 1
char    db      0                   ; current character

trim    proc    far

        xor     si,si               ; initialize buffer pointers
        xor     di,di
        mov     bx,fcb1+1           ; addr of parsed parameter 1
        call    getprm              ; convert it
        cmp     ax,0
        je      trunc               ; zero parameter, go truncate
                                    ; trailing blanks etc.
        mov     param1,ax           ; save first parameter
        mov     bx,fcb2+1           ; addr of parsed parameter 2
        cmp     byte ptr [bx],blank ; is it present at all?
        jne     trim0               ; yes, proceed
        jmp     err3                ; no, exit
```

(Continued on page 100)



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Listing One

```
trim0:
        call    getprm          ; convert it
        mov     param2,ax       ; save 2nd parameter
        cmp     ax,param1       ; is end column < start column?
        jnb     trim1
        jmp     err3            ; yes, exit with error message

trim1:  mov     count,0         ; starting a new line,
                                ; initialize column counter

trim2:  inc     count           ; count characters
        call    cin             ; read a character
        mov     al,char         ; is it carriage return?
        and     al,07fh         ; (ignore high bit in case
        cmp     al,cr           ;  this is Wordstar file)
        je      trim5           ; yes, found end of line
        mov     ax,count        ; fetch current char count
        cmp     sign,0          ; is this include or exclude call?
        jne     trim4           ; jump, -, exclude range
                                ; proceed, +, include range
        cmp     ax,param1       ; is column counter within
                                ; desired range?
        jb      trim2           ; no, discard this char.
        cmp     ax,param2
        ja      trim2           ; no, discard this char.

trim3:  call    cout            ; yes, use this character
        jmp     trim2           ; get next char.

trim4:  cmp     ax,param1       ; is column counter outside
                                ; of excluded range?
        jb      trim3           ; yes, use this character
        cmp     ax,param2
        ja      trim3           ; yes, use this character
        jmp     trim2           ; no, discard this character

trim5:                          ; found end of line
        call    cout            ; write carriage return
        call    cin             ; read presumed line feed
        call    cout            ; write line feed
        jmp     trim1

trunc:                          ; come here if zero parameter
                                ; to delete trailing blanks from
                                ; all lines.  If - sign was in
                                ; command parameter, also delete
                                ; empty lines completely.

trunc1: mov     count,0         ; initialize column counter
        xor     bp,bp           ; init line pointer

trunc2: call    cin             ; read a character
        mov     al,char         ; is it carriage return
        and     al,07fh         ; (ignore high bit in case
        cmp     al,cr           ;  this is Wordstar file)
        je      trunc3          ; yes, go process end of line
        mov     al,char         ; transfer char. to forming line
        mov     byte ptr ds:[line+bp],al
        inc     bp
        cmp     char,blank      ; is character a space code?
        je      trunc2          ; yes, get next char
        mov     count,bp        ; no, update column count
        jmp     trunc2          ; get next char.

trunc3: xor     bp,bp           ; text string now in LINE
        call    cin             ; discard line feed
        cmp     count,0         ; was line empty?
```

```
        jne     trunc4          ; no, go output it
        cmp     sign,0          ; deleting empty lines?
        jne     trunc1          ; yes, discard this one
        jmp     trunc5          ; no, send cr-lf sequence

trunc4:                         ; now transfer LINE to BUFOUT
        mov     al,byte ptr ds:[bp+line]
        mov     char,al         ; get next char and
        call    cout            ; send it to output
        inc     bp
        cmp     bp,count        ; entire line sent yet?
        jb      trunc4          ; no, send another char

trunc5: mov     char,cr         ; send carriage return
        call    cout
        mov     char,lf         ; and line feed
        call    cout
        jmp     trunc1

exit:   cmp     di,0            ; output buffer empty?
        je      exit1           ; yes
        call    outbuf          ; no, flush it
exit1:  mov     ax,4c00h        ; exit with return code=0
        int     21h             ; if no errors were encountered

err:                            ; print error message and exit.
                                ; DS:DX = addr of message
                                ; CX    = length of message
                                ; AL    = return code
        push    ax              ; save return code
        mov     ah,40h          ; function 40 = write
        mov     bx,stderr       ; handle for error output
        int     21h
        pop     ax              ; retrieve return code
        mov     ah,4ch          ; function 4C = exit
        int     21h

err1:   mov     dx,offset err1msg  ; print "output device error"
        mov     cx,err1len
        mov     al,1            ; return code = 1
        jmp     err

err2:   mov     dx,offset err2msg  ; print "disk is full".
        mov     cx,err2len
        mov     al,2            ; return code = 2
        jmp     err

err3:   mov     dx,offset err3msg  ; print "bad parameter"
        mov     cx,err3len
        mov     al,3            ; return code = 3
        jmp     err

err4:   mov     dx,offset err4msg  ; print "input device error"
        mov     cx,err4len
        mov     al,4            ; return code = 4
        jmp     err

trim    endp

cout    proc    near            ; output contents of "char"
                                ; with autobuffering
        mov     al,char
        mov     byte ptr [di+bufout],al
        inc     di
        cmp     di,buflen       ; buffer full yet?
        jb      cout1
        call    outbuf          ; write buffer
cout1:  ret                     ; back to caller
cout    endp
outbuf  proc    near            ; write buffer to std output
        mov     ah,40h          ; function 40 = write
        mov     bx,stdout       ; predefined handle
        mov     cx,di           ; number of characters
        lea     dx,bufout       ; DS:DX = buffer addr
```

(Continued on next page)

Listing One

```
        int     21h             ; request DOS service
        jc      err1            ; jump, device write error
        cmp     ax,di
        jne     err2            ; jump, disk is full
        xor     di,di           ; initialize output buff pointer
        ret                     ; back to caller
outbuf  endp

cin     proc    near            ; input next char with buffering
        inc     si              ; bump input buffer pointer
        cmp     si,topin        ; buffer exhausted?
        jbe     cin2            ; no, jump
        mov     ah,3fh          ; yes, read some more data
        mov     bx,stdin        ; predefined handle
        mov     cx,buflen       ; max length to read
        lea     dx,bufin        ; DS:DX = input buffer addr
        int     21h             ; request DOS service
        jc      err4            ; jump, input device error
        cmp     ax,0            ; end of file?
        jne     cin1
        jmp     exit            ; yes, goto success exit point
cin1:   dec     ax              ; save offset of top of data
        mov     topin,ax
        xor     si,si           ; zero input buffer pointer
cin2:   mov     al,byte ptr [si+bufin]
        mov     char,al         ; get next char
        ret
cin     endp

getprm  proc    near            ; convert numeric parameter to
                                ; binary and return it in AX
        xor     ax,ax           ; initialize forming answer
        mov     cl,[bx]         ; get first char
        cmp     cl,'-'          ; is it minus sign?
        jne     getp2           ; no, jump
        inc     sign            ; yes, set flag and
getp1:  inc     bx              ; bump command string pointer
                                ; past the "-" sign
        mov     cl,[bx]         ; get next char
getp2:  cmp     cl,'0'          ; at least 1 legal digit?
        jb      getp6           ; no, exit
        cmp     cl,'9'
        ja      getp6           ; no, exit
        jmp     getp4
getp3:  inc     bx              ; advance through string
        mov     cl,[bx]
        cmp     cl,'0'          ; make sure legal digit 0-9
        jb      getp5           ; not digit, jump
        cmp     cl,'9'
        ja      getp5           ; not digit, jump
        mov     dl,10           ; previous answer * 10
        mul     dl
getp4:  sub     cl,'0'          ; add in the new digit
        xor     ch,ch
        add     ax,cx
        cmp     ah,0            ; new answer > 255?
        je      getp3           ; no, keep converting
        jmp     err3            ; yes, illegal parameter, exit
getp5:  cmp     byte ptr[bx],blank ; if not digit, must be blank
        jne     getp6           ; exit, bad parameter
        ret                     ; back to caller
getp6:  jmp     err3            ; ... since too far to reach
getprm  endp                    ; direct with conditional branch

err1msg db      cr,lf
        db      'trim: output device error'
        db      cr,lf
```

```
err1len equ     (this byte)-(offset err1msg)

err2msg db      cr,lf
        db      'trim: disk is full.'
        db      cr,lf
err2len equ     (this byte)-(offset err2msg)

err3msg db      cr,lf
        db      'trim: bad parameter'
        db      cr,lf
err3len equ     (this byte)-(offset err3msg)

err4msg db      cr,lf
        db      'trim: input device error'
        db      cr,lf
err4len equ     (this byte)-(offset err4msg)

bufin   equ     this byte       ; data is read here
                                ; from the standard input

bufout  equ     bufin+buflen    ; data to be written to
                                ; standard output is built here

line    equ     bufout+buflen   ; temporary line buffer

cseg    ends

        end     start
```

End Listing One

(Listing Two begins on next page)

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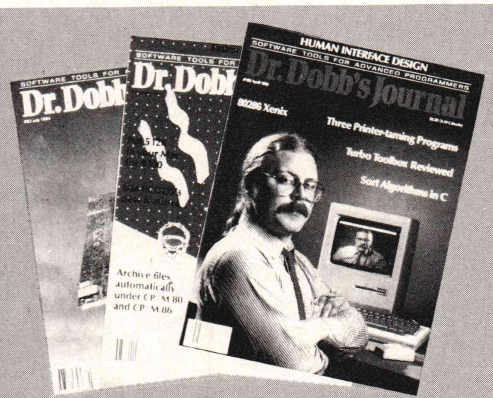

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Listing Two

```
1                                       name    optest
2                                       page    55,132
3                                       title   'OPTEST -- test MASM bugs'
4                                   ; Demonstrate some anomalies in the Macro Assembler v. 2.
5                                   ; This was run on MASM.EXE file dated 7-18-84
6
7       0000                        cseg    segment para public 'CODE'
8                                       assume  cs:cseg,ds:cseg,es:cseg
9       0100                            org     100h
10                                  ;
11                                  ; SHR and SHL don't distinguish between signed and unsigned data
12      0100  0001                       dw      -2 shr 1
13      0102  0001                       dw      2 shr 1
14      0104  0002                       dw      -1 shl 1
15      0106  0002                       dw      1 shl 1
16                                  ;
17                                  ; EQ and NEQ seem to recognize the decimal and hex equivalents...
18      0108  FFFF                       dw      -1 eq 0ffffh
19      010A  0000                       dw      -1 ne 0ffffh
20                                  ;
21                                  ; but the comparison operators don't ...
22      010C  FFFF                       dw      1 gt -1
23      010E  0000                       dw      1 gt 0ffffh
24      0110  0000                       dw      1 lt -1
25      0112  FFFF                       dw      1 lt 0ffffh
26                                  ;
27                                  ; on MOV instructions, if source operand is missing, no
28                                  ; error message is produced and machine code is generated
29                                  ; as though the source operand were an immediate "0".
30      0114  3D 0000                    cmp     ax,
31
32                                  ; generates the same machine code as
33      0117  3D 0000                    cmp     ax,0
34                                  ;
35                                  ; Assembler generates erroneous machine code when last digit of a
36                                  ; literal is "B" or "D" and the default radix is hexadecimal
37      0010                             .radix  16
38      011A  83 EB 0A                   sub     bx,0a
39      011D  83 EB 00                   sub     bx,0b   ; generates same code as SUB BX,0
40      0120  83 EB 0C                   sub     bx,0c
41      0123  83 EB 00                   sub     bx,0d   ; generates same code as SUB BX,0
42      0126  83 EB 0E                   sub     bx,0e
43
44      0129                        cseg    ends
45                                      end
```

End Listings

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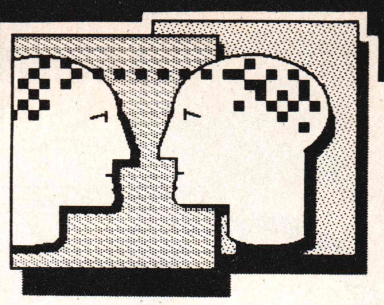


by Robert Blum

Alternate Console for SID

Necessity was the mother of invention that spurred Bridger Mitchell of Plu*Perfect Systems to develop this useful modification for ZSID, SID, or DDT. Apparently during the development and debugging of a CRT screen-handling routine, Mitchell realized that he had to find an alternate path for the messages coming from the debugging program. Each time SID displayed a message, it altered the context of the original screen, making it practically impossible to decide whether the screen-handling routine was functioning properly. Even worse, performing an instruction trace completely destroyed the screen contents: as each instruction executed, a new line of information from SID was displayed, scrolling yet another data line off the top of the CRT screen, until the screen was filled with nothing but messages from the debugger. This was no help at all in determining how the routine under test was interacting with the CRT.

Mitchell developed SID2TTY to provide a standard way of interacting with the BDOS to direct application program messages to one display device while providing an additional path for any messages coming from the debugging program. This program dynamically patches the SID debugger to redirect all of its console input and output to the logical TTY: device while allowing the program under test to continue using the CRT: device undisturbed. If you are using either ZSID or DDT, you should use ZSID2TTY and DDT2TTY, respectively, to patch the debugger.

By using a second terminal as the TTY: device to "command" SID, you can debug programs without interfering with standard console input and output. Assuming the usual CON: =CRT: device assignment, a program's standard output will appear on the video monitor exactly as if the debugger were not in use; program input is entered on the standard keyboard. All debugger input comes from the TTY: console, and debugger output appears on the TTY: video monitor. The patch in the Listing (page 107) is only 23 bytes long, the remainder of the code providing the necessary relocation and memory protection services.

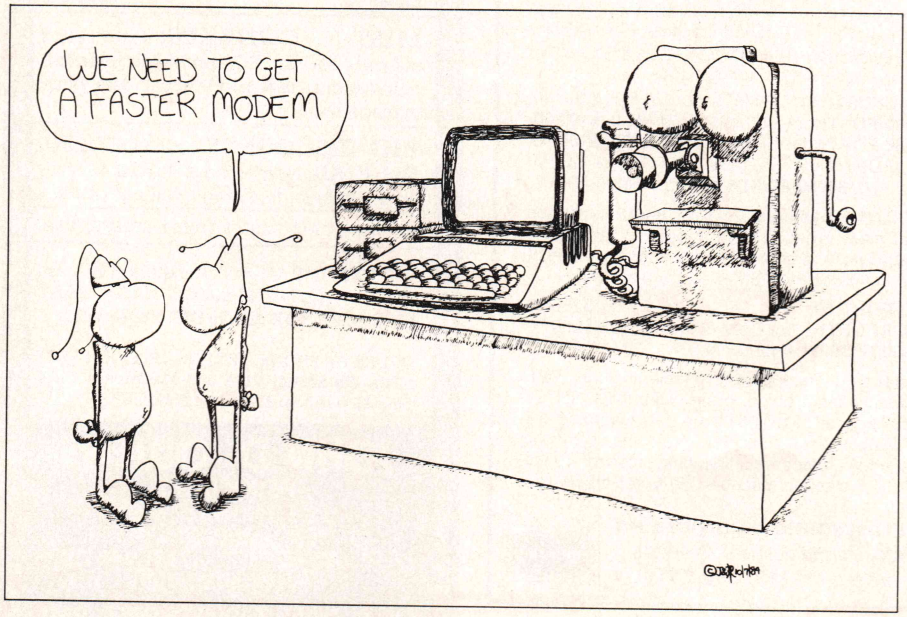
In operation, each time SID calls for BDOS console I/O service, SID2TTY changes the IOBYTE to reflect a console assignment of TTY: and restores it to the original value afterwards. To protect high memory, the patch is relocated below SID and also below any .SYM and .UTL files, which should be loaded first. Operating procedures are well documented within the program source listing.

CP/M Plus Inaccuracy

The CP/M Plus documentation states that the fourth field of a RSX header, labeled PREVIOUS, contains a 16-bit pointer to the previous RSX in the chain or to memory location 5 if no other RSXs are active. This suggests that the PREVIOUS pointer, in fact, always points to the NEXT jump instruction of the previous RSX in the chain. Thus, compatibility is maintained throughout the system, and each RSX is chained in both forward and backward directions.

In actuality, though, this pointer is to location 7, the last byte of the jump NEXT field in the previous RSX, or to memory location 7 if no other RSXs are active. This inaccuracy has no effect on CP/M Plus's operation or on any RSX currently supplied by DRI. But beware if you are planning to write any custom RSXs that might use reverse chaining.

DDJ



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CP/M Exchange Listing

```
;       SID2TTY.ASM v 1.1  01/10/84     B. Mitchell (Plu*Perfect Systems)
;
;
;           A Debugging Console for SID, ZSID and DDT
;
;SID2TTY is a small, public-domain program that
;dynamically patches the SID debugger (Data Resources, Inc.) to
;redirect all of SID's console input and output to the logical TTY:
;device.  (ZSID2TTY and DDT2TTY are the ZSID and DDT versions.)
;
;By using a second terminal as the TTY: device to "command" SID,
;one can debug programs without interfering with standard console
;input and output.  Assuming the usual CON:=CRT: device assignment,
; a program's standard output will appear on the video
;monitor exactly as if the debugger were not in use, and program
;input will be entered on the standard keyboard.  All debugger
;input comes from the TTY: console, and debugger output appears
;on its video monitor.
;
;The patch itself is just 23 bytes -- it changes the IOBYTE each time
;SID calls for BDOS console i/o service and restores it afterwards.
;The patch is relocated to protected high memory, below SID (and
;below any .SYM and .UTL files, which should be loaded first).
;
;Running SID2TTY will display a help message.
;
;Source file:   SID2TTY.ASM for assembly with ASM or MAC.
;               The ZSID and DDT versions are obtained by
;               changing three equates.
;
;Requirements:  CP/M 2.2 - 3.0 with IOBYTE implemented in bios.
;               8080, 8085 or Z80 CPU.
;               SID v. 1.4 or ZSID v. 1.4 or DDT v2.2.
;               External terminal connected to TTY:.
;
;Installation:  Set the equates for SID, ZSID or DDT.
;               If your TTY: device needs initialization or
;               de-initialization, insert the code in place
;               of dummy routines.
;
;Bugs:          Exiting from SID with ^C leaves the console
;               redirected to TTY: (unless the BIOS improperly
;               restores the IOBYTE on warmboots).  The
;               recommended fix is simply to exit with a "G0".
;               Should you happen to hit ^C, reload SID and reset
;               the IOBYTE to its original value, then exit with
;               ^C from the CRT terminal.
;
;Remarks:       1. Although it would be possible to trap the
;               warmboot and restore the IOBYTE, it's difficult to
;               do correctly.  Trapping 0001h violates the basic CP/M
;               addressing convention, making it impossible to
;               run other resident modules that need to locate the BIOS
;               and BDOS.  Trapping the warmboot at the BIOS jump
;               vector does preserve addressing, but it still requires
;               special efforts to maintain compatibility with any higher
;               resident modules, and the trap must remove itself
;               without disturbing them.  Since the application here
;               is manual, interactive debugging, it seems best to
;               favor compatibility and do a manual restoration.
;
;               2. The assembler portion of SID/ZSID can be removed
;               with the "-A" command to gain 680h bytes, but
;               this must be done BEFORE installing the patch
;               with the "g103" command.
;
;Version:       1.0     --      10 October 1984 B. Mitchell
;               1.1     --      10 January 1985 B. Mitchell
;
;Revisions:     Please forward any revisions and improvements
;               to the author.
```

(Continued on next page)

```
;
;Author:         Bridger Mitchell
;               Plu*Perfect Systems
;               Box 1494, Idyllwild CA 92349
;               (714) 659-4432
;
;Note:           Not tested on CP/M 3.0.
;
;
VERS    equ     1$1
;
FALSE   equ     0
TRUE    equ     NOT FALSE
ADDRESS equ     0FFFFH
;
; exactly ONE of the next 3 equates must be TRUE --
;
SID     equ     TRUE
ZSID    equ     FALSE
DDT     equ     FALSE
;
CR      equ     0dh
LF      equ     0ah
BELL    equ     07h
;
IOBYTE  equ     0003h
BDOS    equ     0005h
;
        org     100h
START:  jmp     HELP
        jmp     INSTALL
        jmp     DEINITTTY
;
signature:db    'NEXT  PC'      ;common SID/ZSID/DDT code
siglen  equ     $-signature

        IF SID
;
modsiz  equ     1800h   ;size of debugger module
sigad   equ     0E42h   ;offset to signature
callbd  equ     06A4H   ;offset to call_bdos routine
fn2ad   equ     1004h   ;offset to addr of function 2 bdos call
fn10ad  equ     0FF2H   ; ditto fn 10
fn11ad  equ     1065h   ; ditto fn 11

;
usage:  db      CR,LF,'SID2TTY v. '
        db      vers/10+'0','.',(vers mod 10)+'0'
        db      '  --  Redirect SID console i/o to TTY:',CR,LF
        db      '          -- Usage --',CR,LF
        db      'Load SID, then .SYM and .UTL files',CR,LF
        db      '  #I* filename.SYM',CR,LF
        db      '  #R',CR,LF
        db      '  #ISID2TTY.COM',CR,LF
        db      '  #R',CR,LF
        db      '  #G103       ==>> SID''s console is now TTY:',CR,LF
        db      '  #Ifilename.COM  (or .HEX) to debug',CR,LF
        db      '  #R',CR,LF
        db      '  #D3,3       ==>> display IOBYTE for reference',CR,LF,LF
        db      'To exit from SID, deinitialize the TTY: (if needed) by',CR,LF
        db      '  #ISID2TTY.COM',CR,LF
        db      '  #R0',CR,LF
        db      '  #G106',CR,LF
        db      'Then use "G0" (not "^C") to exit from SID.',CR,LF
        db      '(This message can be displayed under SID by the command:'
        db      CR,LF,'   G100  or   C100 before loading ''filename'')'
        db      CR,LF,LF,'$'
;
errmsg: db      CR,LF,BELL,'Can''t find SID v 1.4!$'
        ENDIF   ;IF SID

        IF ZSID
```

(Continued on page 110)

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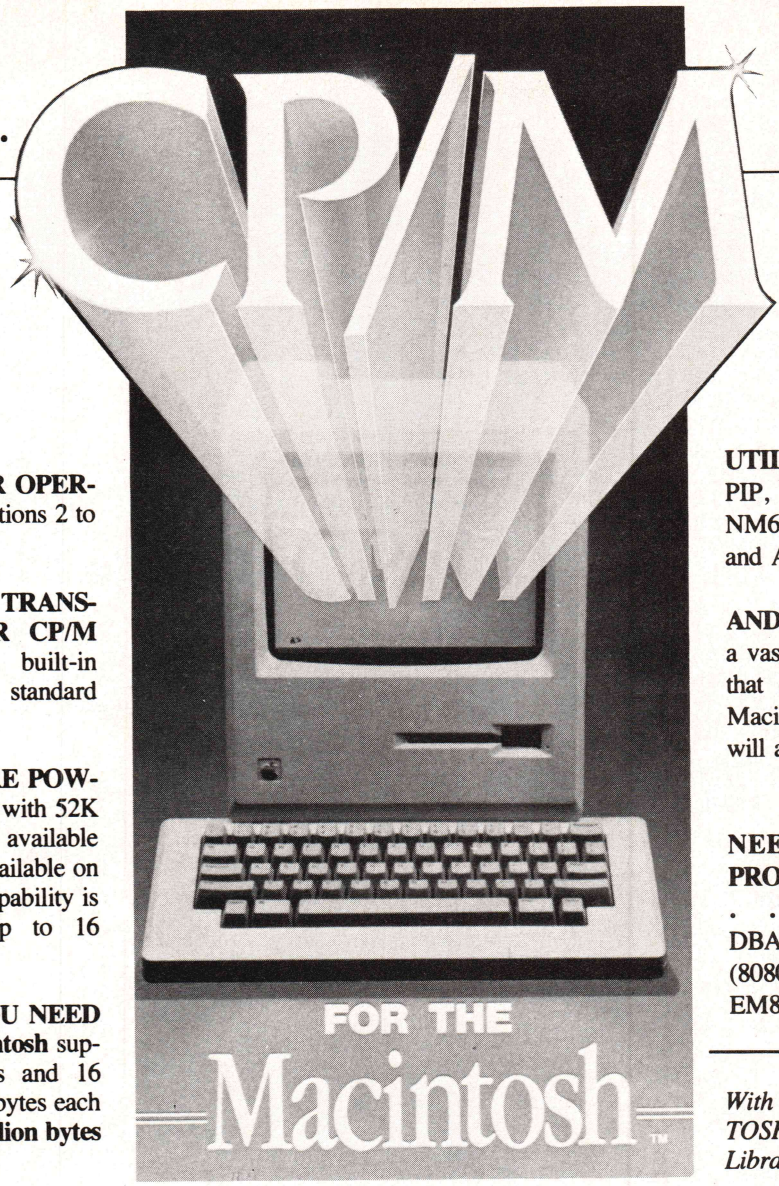

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CP/M Exchange Listing (Listing continued, text begins on page 106)

```
;
modsiz  equ     2200h
sigad   equ     1682h
callbd  equ     0EAFH
fn2ad   equ     1880h
fn10ad  equ     186Eh
fn11ad  equ     18E1h
;
usage:  db      CR,LF,LF,'ZSID2TTY v. '
        db      vers/10+'0','.',(vers mod 10)+'0'
        db      '  --  Redirect ZSID console i/o to TTY:',CR,LF,LF
        db      '          -- Usage --',CR,LF
        db      'Load ZSID, then .SYM and .UTL files',CR,LF
        db      '  #I* filename.SYM',CR,LF
        db      '  #R',CR,LF
        db      '  #IZSID2TTY.COM',CR,LF
        db      '  #R',CR,LF
        db      '  #G103       ==>> ZSID''s console is now TTY:',CR,LF
        db      '  #Ifilename.COM  (or .HEX) to debug',CR,LF
        db      '  #R',CR,LF
        db      '  #D3,3       ==>> display IOBYTE for reference',CR,LF,LF
        db      'To exit from ZSID, deinitialize the TTY: (if needed) by',CR,LF
        db      '  #IZSID2TTY.COM',CR,LF
        db      '  #R0',CR,LF
        db      '  #G106',CR,LF
        db      '(This message can be displayed under ZSID by the command:'
        db      CR,LF,'   G100  or   C100 before loading ''filename'')'
        db      CR,LF,LF,'$'
;
errmsg: db      CR,LF,BELL,'Can''t find ZSID v 1.4!$'
        ENDIF   ;IF ZSID

        IF DDT
;
modsiz  equ     1000h
sigad   equ     0A71h
callbd  equ     06A2h
fn2ad   equ     0BCEh
fn10ad  equ     0C25h
fn11ad  equ     0BBCh
;
usage:  db      CR,LF,LF,'DDT2TTY v. '
        db      vers/10+'0','.',(vers mod 10)+'0'
        db      '  --  Redirect DDT console i/o to TTY:',CR,LF,LF
        db      '          -- Usage --',CR,LF
        db      'A>DDT DDT2TTY.COM',CR,LF
        db      '  -G103       ==>> DDT''s console is now TTY:',CR,LF
        db      '  -Ifilename.COM  (or .HEX) to debug',CR,LF
        db      '  -R',CR,LF
        db      '  -D3,3       ==>> display IOBYTE for reference',CR,LF,LF
        db      'To exit from DDT, deinitialize the TTY: (if needed) by',CR,LF
        db      '  -IDDT2TTY.COM',CR,LF
        db      '  -R0',CR,LF
        db      '  -G106',CR,LF
        db      '(This message can be displayed under DDT by the command:'
        db      CR,LF,'   G100 before loading ''filename'')'
        db      CR,LF,LF,'$'
;
errmsg:db       CR,LF,BELL,'Can''t find DDT v 2.2!$'
        ENDIF   ;IF DDT
;
;
; Display usage message & quit.
;   This is executed if SID2TTY is run as a .COM file
;   It can also be C'd or G'd from the debugger.
;
HELP:   lxi     d,usage
print:  mvi     c,9
        call    bdos
```

(Continued on page 112)

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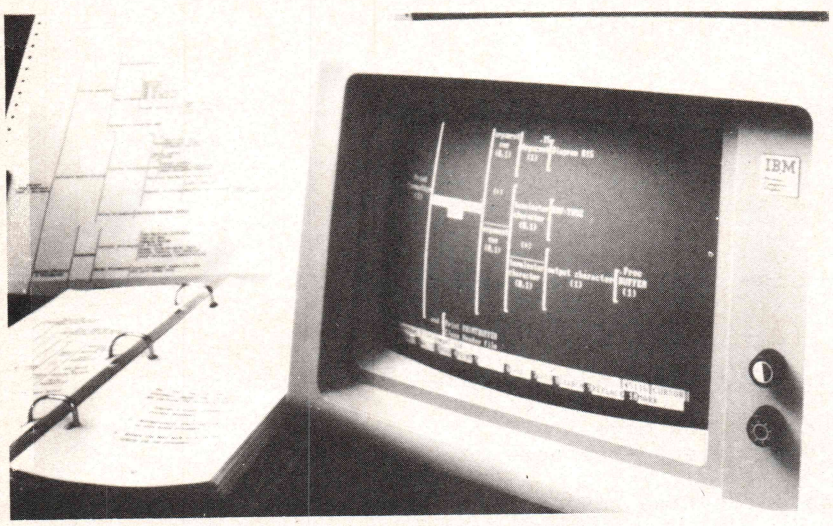

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```
        lxi     h,0             ;is debugger in use on default stack?
        dad     sp
        mov     a,h
        cpi     2
        rnc                     ;return to caller (ccp)
        rst     7               ;return to debugger
;
ERR:    lxi     d,errmsg
        jmp     print
;
;
; Search for debugger signature in high memory.
;   Search downward to find first image of the debugger,
;   in case other copies are lying around.  This also
;   allows other resident modules to exist above the
;   debugger.  Debugger is always located on a page boundary.
;
INSTALL:
        lhld    1
        lxi     d,-(modsiz+3)
        dad     d               ;start at max possible addr
search: push    h
        lxi     d,sigad
        dad     d
        call    compar
        pop     h
        jz      found
        mov     a,h
        cpi     10h             ;quit looking at 1000h
        jc      err
        dcr     h               ;try 1 page lower
        jmp     search

compar: lxi     d,signature
        mvi     b,siglen
complp: ldax    d
        cmp     m
        rnz
        inx     h
        inx     d
        dcr     b
        jnz     complp
        ret
;
; Debugger located.  Calculate run-time addresses & patch
;   into code and debugger.
;
found:  push    h               ; save base addr of debugger
        lxi     d,callbd        ;put 3 run-time addresses into code
        dad     d
        xchg
        lxi     h,patch1        ;1: the call_bdos routine address
        mov     m,e
        inx     h
        mov     m,d
        lhld    6               ;2: the protect address/base of high code
        shld    patch2
        lxi     d,-codelen      ;protect the code
        dad     d               ;(don't trace from here to lpend)
        shld    6
        push    h               ;save run-time base of high code
        lxi     d,saviob-code
        dad     d
        shld    patch3          ;3: the save-iobyte address

        pop     d               ;get destination
        push    d
        lxi     h,code          ;move the code into place
        mvi     b,codelen
```

(Continued on page 114)

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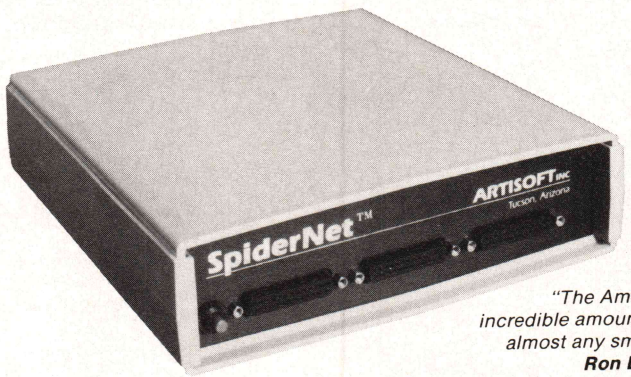

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CP/M Exchange Listing

(Listing continued, text begins on page 106)

```
lp:     mov     a,m
        stax    d
        inx     h
        inx     d
        dcr     b
        jnz     lp
;
lpend:  pop     b               ;patch debugger's console io calls
        inx     b
        inx     b
        inx     b               ; ..to point at code entry ('divert')
        pop     d               ;de = base of debugger
        lxi     h,fn10ad        ;index into debugger module
        dad     d
        mov     m,c             ;plug 3 diversion addresses into calls
        inx     h
        mov     m,b
        lxi     h,fn2ad
        dad     d
        mov     m,c
        inx     h
        mov     m,b
        lxi     h,fn11ad
        dad     d
        mov     m,c
        inx     h
        mov     m,b
        jmp     INITTTY         ;do any user-supplied initialization
;
;
; The REDIRECTION CODE, which is moved up just below the debugger
;
patch2  equ     $+1
CODE:   jmp     ADDRESS         ;jmp to debugger entry
divert: lxi     h,iobyte
        mov     a,m
patch3  equ     $+1
        sta     ADDRESS         ;save the iobyte
        ani     0fch            ; assign CON:  to TTY: for debugger
        mov     m,a
patch1  equ     $+1
        call    ADDRESS         ;debugger's call_bdos routine
saviob  equ     $+1
        mvi     a,00            ;restore user's iobyte
        sta     iobyte
        mov     a,l             ;get bdos return param back to A
        ret
codelen equ $-code

;
; User-supplied TTY: initialization routine.
;   Use this to set baud rate, channel parameters, etc.
;
INITTTY:
        rst 7                   ;return to debugger on TTY: device
;
; User-supplied TTY: de-initialization routine.
;   Use this to restore TTY: device to regular settings.
;
DEINITTTY:
        rst 7                   ;return to debugger on TTY: device

        END
```

End Listing

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A general purpose text processor, the MIX Editor is packed with features that make it useful with any language. It has auto indent for structured languages like Pascal or C. It has automatic line numbering for BASIC (255 character lines). It even has fill and justify for English.

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A utility for defining terminal features (smart features included) allows the editor to work with any terminal. Over 30 of the most popular terminals are built-in.

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Commands are mapped to keys just like WordStar. If you don't like the WordStar layout, simply change it. Any key can be mapped to any command. You can also define a key to generate a string of characters, great for entering keywords.

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You can split the screen horizontally or vertically and edit two files simultaneously.

Macro Commands

The MIX Editor allows a sequence of commands to be executed with a single keystroke. You can define a complete editing operation and perform it at the touch of a key.

Custom Setup Files

Custom keyboard layouts and macro commands can be saved in setup files. You can create a different setup file for each language you use. The editor automatically configures itself using a setup file.

Command Mode

Command mode allows any editor command to be executed by name. It is much easier to remember a command name versus a complicated key sequence. Command mode makes it easy to master the full capability of the editor. Frequently used commands can be mapped to keys. Infrequent commands can be executed by name.

Editor Commands

The editor contains more than 100 commands. With so many commands, you might think it would be difficult to use. Not so, it is actually extremely simple to use. With command mode, the power is there if you need it, but it doesn't get in your way if you don't. Following is a list of some of the commands.

Cursor Commands

Left/Right/Up/Down
Tab Right/Tab Left
Forward Word/Backward Word
Beginning of Line/End of Line
Scroll Up/Scroll Down
Window Up/Window Down
Scroll Left/Scroll Right
Top of File/Bottom of File
• • •

Block Commands

Copy/Move/Delete
Read/Write
Lower Case/Upper Case
Fill/Justify
Print

File Commands

Directory (with wild cards)
Show File/Help File
Input/Output File
Delete File/Save File

Other Commands

Split Screen/Other Window
Find String/Replace String
Replace Global/Query Replace
Delete Line/Undelete Line
Delete Word/Undelete Word
Insert Mode/Overwrite Mode
Open Line/Join Line
Duplicate Line/Center Line
Set Tab/Clear Tab
• • •

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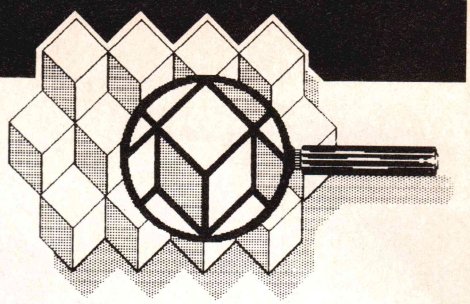

by Alex Ragen

If you've ever traveled outside the United States, you've probably noticed that the household electricity varies from country to country. The line voltage may be 110 or 120 or 220 or 240 volts, and the frequency may be either 50 or 60 Hz. Even if your electric shaver or hair dryer has a little switch somewhere to flip back and forth among all the possible combinations, you still may find that you can't use it because the plug doesn't fit the wall receptacle. It turns out that almost every country in the world has its own unique plug shape, which is not only different but also superior to every other country's plug shape. Does this remind you of anything?

Software and hardware expend a tremendous amount of computing energy in converting between languages, protocols, disk formats, operating systems, and so on. You can run CP/M 80 or MSDOS on your Macintosh or use your IBM PC (and compatibles, of course!) to write Apple II disks or run a 68000 board. Whatever designers intended users to do on one configuration, they have managed to implement on another as well. This Babel of standards and not-so-standards is chaotic, confusing, pointless, and counterproductive—and we've all had lots of fun and worked hard getting around it.

Perhaps one day we'll live in a perfect world. Everything will interface with everything else, Macintosh add-ons won't be called Mac-this or Mac-that, and a word processor will emerge that is so good that nobody will want to write another one.

C Language

Lattice Inc. is offering an upgrade kit to users of Microsoft's MSDOS C compiler. For $150 and the original Microsoft diskettes, Lattice will provide version 2.20 of its C compiler, the C-SPRITE debugger, and a typeset manual. The regular retail price of the package is $675, and the offer is good until July 31, 1985. Contact Lattice Inc. at P.O. Box 3148, Glen Ellyn, IL 60138 (312) 858-7950. **Reader Service No. 101.**

QTools, a programmer's toolbox of 19 tools adapted from Unix to PCDOS, is available for $49.95 postpaid from QCAD Systems, 1164 Hyde Ave., San Jose, CA 95129 (800) 538-9787 or (408) 255-5574 in California. **Reader Service No. 103.**

A new C language **scientific subroutine library** that provides IBM PC users with 112 pretested and precompiled mathematical and statistical subroutines is available from Wiley Professional Software. The subroutines include the most commonly used operations such as differentiation, polynomials, probability, numerical integration, regression, differential equations and others. Over 400 pages of documentation provide a description of methodology, notes on special considerations, source code, test programs, and results. The library requires the Lattice C compiler, version 2.12 or later, and a two-drive IBM PC. Contact Leslie Bixel, Wiley Professional Software, 605 Third Ave., New York, NY 10158 (212) 850-6788. **Reader Service No. 105.**

TGL Inc. has released version II of **The Converter**, an IBM PC program that automatically converts UCSD, MT+, and MS-Pascal source programs into equivalent C programs. Ted Lewis of TGL points out that The Converter correctly handles nested procedures, separately compiled units or modules, and intrinsic functions; it also enables developers to move quickly from UCSD or MSDOS to Unix. Contact Mr. Lewis at TGL Inc., 4400 Sulphur Springs Rd., Corvallis, OR 97330 (503) 745-7476. **Reader Service No. 107.**

Thunder Software has announced version 2.0 of its **Thunder C**, the only C compiler available for the Apple Pascal and Apple ProDOS environments. Thunder C generates native 6502 assembly language routines, and its developers rate the new version as 300 percent faster than the old one. It runs under Apple Pascal 1.1 or 1.2, although the ProDOS version requires an external ProDOS macro assembler. Price is $49 plus $3 shipping. The company also offers LINKIT, a linking loader and library generator; XREF, a Pascal cross-reference utility; and ASSYST, a 6502 assembler. Contact Thunder Software at P.O. Box 31501, Houston, TX 77231 (713) 728-5501. **Reader Service No. 109.**

Hippo-C is the only (so far) C compiler for the Macintosh with a source-level debugger—or so its developers claim. Level 1 provides access to over 380 Toolbox and Quickdraw routines and features a compiler, editor, standard C library, on-line tutorial, debugger, linker, shell command processor, many sample programs, and over 200 pages of documentation. It's priced at $149.95. Level 2 includes all Level 1 features plus an optimizing compiler, assembler, and full floating-point support. It sells for $399.95. Contact Hippopotamus Software at 1250 Oakmead Pkwy., Sunnyvale, CA 94086 (408) 738-1200. **Reader Service No. 111.**

Modula 2

Release 1.10 of **Modula-2/86 for PCDOS** is now available from Logitech. A library of programming tools is also available. Contact Chris Cale at Logitech, 805 Veterans Blvd.,

Redwood City, CA 94063 (415) 365-9852. **Reader Service No. 113.**

Modula-2 for Z80-based CP/M systems is available from Hochstrasser Computing AG, Leonhardshalde 21, CH-8001 Zurich, Switzerland, phone 01/47 55 48. The cost is sFr 400 or about $150. **Reader Service No. 115.**

MSDOS

Guess who is throwing its hat into the cutthroat world of the IBM PC add-on market? None other than Intel, which has established a **Personal Computer Enhancement Operation.** The first two products are its well-known 8087 and 80287 math co-processors (what's next, the 8086?). Contact Intel at 520N.E. Elam Young Pkwy., Hillsboro, OR 97124-6497 (503) 629-7369. **Reader Service No. 117.**

PC-68K is an upgrade package—plug-in board and software—that adds development support for Motorola's 68000 family to IBM's PC XT and PC AT running PCDOS. PC-68K provides a symbolic debugger, linker/locator, Motorola compatible macro assembler, and IEEE floating-point package. Pascal and C compilers and communications utilities are extra-cost options. The board features an 8 MHz 68000 cpu and 256 – 1024K of RAM. Prices start at $2995 for the 256K version. Contact Carrie Ann Moran at Language Resources, 4885 Riverbend Rd., Boulder, CO 80301 (303) 449-8087. **Reader Service No. 119.**

The **Buddy System** enables a support person located at a central facility to "take over" a remotely located IBM PC in order to resolve a customer's problem. The developer has been using it internally for three years to support its products and now offers it to others at $199. You load the Buddy System when you turn on your PC; thereafter, it's dormant until you activate the "copilot" mode and contact the support center via modem. The support person then observes you, the user, as the application is executed and can even take control of the application to show you what to do. A number of other features, such as help, screen snapshot, screen copy to file, and record/replay support session, are designed to increase the productivity of the support operation. Contact Edward Murphy at Solvation Inc., 302 Turnpike Rd., Southboro, MA 01722 (617) 481-9390. **Reader Service No.121.**

Phoenix Software Associates has introduced an IBM PC/AT-compatible ROM BIOS that was developed under strict controls specifically to ensure originality and to avoid copyright infringement suits. The company had already developed versions for the PC and PC/XT. The PC/AT version is offered to OEMs for unlimited use licensing at a price of $440,000. The PC and PC/XT versions are $290,000. Contact Richard Levandov at 1420 Providence Hwy., Suite 101, Norwood, MA 02062 (617) 769-7020. **Reader Service No. 123.**

Ryan McFarland's **RM/Cobol** is now available for the IBM PC/IX user. It was already available for the IBM PC under PCDOS, as well as for the IBM Series 1 under Unix and the IBM 370 computers under VM/CMS. The new RM/Cobol is priced at $230 for the runtime version and $750 for

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the full version. Contact Ryan McFarland Corp., 609 Deep Valley Dr., Rolling Hill Estates, CA 90274 (213) 541-4828. **Reader Service No. 125.**

A full ANSI **Fortran 77 compiler** for the IBM PC has been announced by Lahey Computer Systems. The complete package, including a 250 page manual, customer telephone support, and newsletters, costs $477 and requires 256K RAM and an 8087 coprocessor. The compiler claims Lattice C compatibility. Contact the vendor at 31244 Palos Verdes Dr. West, Suite 243, Rancho Palos Verdes, CA 90274 (213) 541-1200. **Reader Service No. 127.**

Scroll and Recall lets the IBM PC user scroll back through 27 pages of previously displayed screens while saving you DOS commands, which you can then recall, edit, and reuse without having to type them in again. The cost is $69. Contact Dennis P. Olenick, Opt-Tech Data Processing, P.O. Box 2167, Humble, TX 77347 (713) 454-7428. **Reader Service No. 129.**

The **GTP Program Development System** is a productivity tool for Turbo Pascal programmers. Basically, it generates the Turbo Pascal statements for handling screen data entry. It requires PCDOS or MSDOS version 2.0 or higher, and lists for $99.95. Contact AEF Software, P.O. Box 928, Katy, TX 77449 (713) 391-8570. **Reader Service No. 131.**

FREECOPY is functionally equivalent to DISKCOPY, which is distributed as part of PCDOS. Although it is basically DISKCOPY reverse engineered, the author claims not to have violated the proprietary rights of either IBM or Microsoft. Commented source code is included. The author is placing the program in the public domain but does request a $25 contribution. Contact Donald Buresh, Squire Buresh Associates, 18 Dorothy Rd., Millbury, MA 01527 (617) 865-3435. **Reader Service No. 133.**

Modular Bridge is a product that allows you to transfer files between PCDOS and the PICK PC-XT operating system. Contact Modular Software, P.O. Box 204, Union City, GA 30291 (404) 964-7171. **Reader Service No. 135.**

HFORMAT and **HTEST** are two programs that address the problems of formatting hard disks on the PC family. The programs test and perform the equivalent of factory formatting on the drives. Contact Marcus Kolod at Kolod Research, P.O. Box 68, Glenview, IL 60025 (312) 291-1586. **Reader Service No. 137.**

A **Universal PROM programmer** for the IBM PC is offered for $250 by Advanced Microcomputer Systems of 6802 N.W. 20th Ave., Ft. Lauderdale, FL 33309 (305) 975-9515. **Reader Service No. 139.**

HelpDOS is a menu-driven on-screen reference for PCDOS and includes a technical dictionary. It requires PCDOS or MSDOS, version 2.0 or later, and is available for $49.95 from Help Technologies, P.O. Box 50834, Palo Alto, CA 94303 (415) 856-3431. **Reader Service No. 141.**

Superkey, a resident keyboard enhancer for data encryption and macro processing, has been announced by Borland International, the Turbo

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Pascal people. The program is basically a shortcut to routine entry of often-used commands, like those required for logging onto RBBS services or formatting letters and spreadsheets. The user can bring up Superkey, move around in the program, and exit with single-keystroke operations, as well as pull its full-screen macro editor down on top of the main program. It also provides on-line help, automatic recall of the last 20 entered commands, cut and paste capability, data encryption/decryption, and screen burn-in protection. Contact Borland International, 4113 Scotts Valley Dr., Scotts Valley, CA 95066 (408) 438-8400. **Reader Service No. 143.**

SEE is an editor for "professional programmers" from Prologic Corp., 31324 Via Colinas, Suite 111, Westlake Village, CA 91362 (818) 991-5062. **Reader Service No.145.**

A new version of **PC/Forth** for the PC/AT, running under 80286 XENIX 3.0, has been announced by Laboratory Microsystems, 3007 Washington Blvd., Suite 230, P.O. Box 10430, Marina del Rey, CA 90295 (213) 306-7412. **Reader Service No. 147.**

The Echo PC2 is a speech synthesizer card for the IBM PC. The manufacturer, having previously provided similar products for the Apple, claims to be the first to produce one for the IBM PC. It features two speech modes: a limited vocabulary (about 700 words) in a natural-sounding female voice and an unlimited vocabulary in a robotic-sounding voice. Some 400 English language and pronunciation rules have been utilized to produce the computer-synthesized speech. Software can control pitch and volume. The board fits into the PC's short slots and comes with a speaker, software, and an instruction manual. The price is $149.95. Contact Street Electronics Inc., 1140 Mark Ave., Carpinteria, CA 93013 (805) 684-4593. **Reader Service No. 149.**

BIS7705 allows an IBM PC to emulate all the functions of a Honeywell 7700/7705 terminal. The price is $695, and it's available from IE Systems Inc., 112 Main St., Newmarket, NH 03857 (603) 659-5891. **Reader Service No. 151.**

CP/M 80

DSD80 is a fully DDT-compatible full-screen symbolic debugger for 8080, 8085, and Z80-based CP/M 80 systems. DSD80 includes port I/O, string searching, and symbol definition. The Z80 instruction set is fully supported using either extended Intel or Zilog mnemonics. There is an on-line help facility, and the program comes with a 50-page user's manual. The price is $125. Contact Soft Advances, P.O. Box 49473, Austin, TX 78765 (512) 478-4763. **Reader Service No. 153.**

CP/M users needn't feel left out in the cold by the latest fad of pop-up programs. Poor Person Software has announced **Write-Hand-Man**, which includes a notepad, phone book, desk calendar, file and directory viewing programs, and a communication program. Users familiar with CP/M programming can add new functions. Write-Hand-Man requires CP/M 2.2

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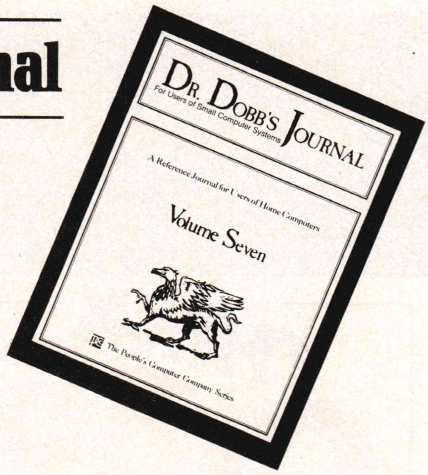

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and will run on all CP/M machines. The price is $49.95. The program is available from Poor Person Software, 3721 Starr King Circle, Palo Alto, CA 94306 (415) 493-3735. **Reader Service No. 155.**

MB+ Tools is a set of programmer productivity tools for Pascal MT+. It's currently available for CP/M 80 and CP/M 86, and it should be available for MSDOS late this year. The price is $175. Contact Michael Nunamaker, Minnow Bear Computers, P.O. Box 2233, Champaign, IL 61820-8233 (217) 398-6883. **Reader Service No. 157.**

Macintosh

MacCharlie is not a trampburger but a $985 box that attaches to the Macintosh and allows it to run programs written for the IBM PC. MacCharlie also allows Macintosh users to connect to IBM PC serial networks and to use IBM PC-compatible printers. Contact Robert Barrett at Dayna Communications, 50 South Main St., Suite 530, Salt Lake City, Utah 84144 (801) 531-0600. **Reader Service No. 153.**

Mighty Mac is a personal information manager priced at $99 from Advanced Logic Systems at 1195 E. Arques Ave., Sunnyvale, CA 94086 (408) 730-0307. **Reader Service No. 155.**

FileMaker (the third product in the MACWARE line) is a single-file data base system that allows a user to create a variety of custom-designed reports and forms that include text and graphics. FileMaker takes full advantage of the "visually active" Macintosh environment and functions within the Macintosh Office recently announced by Apple. Contact Forethought Inc., 1973 Landings Dr., Mountain View, CA 94043 (800) MACWARE. **Reader Service No. 129.**

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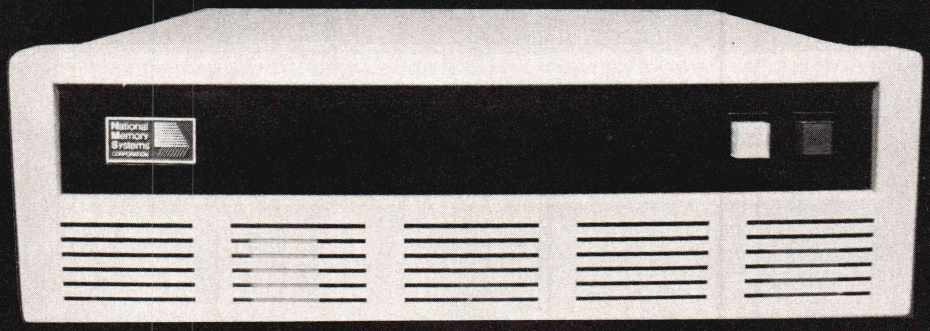

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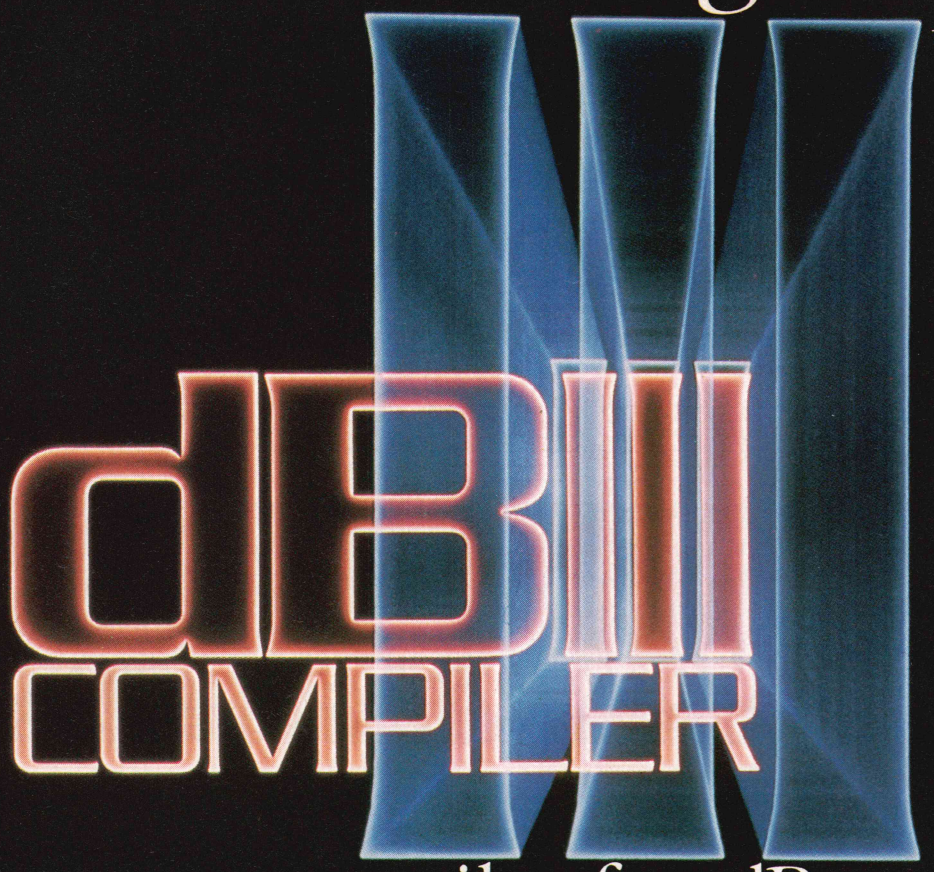

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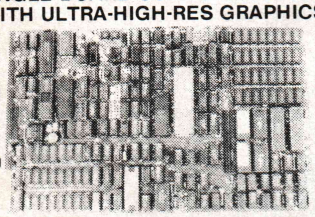

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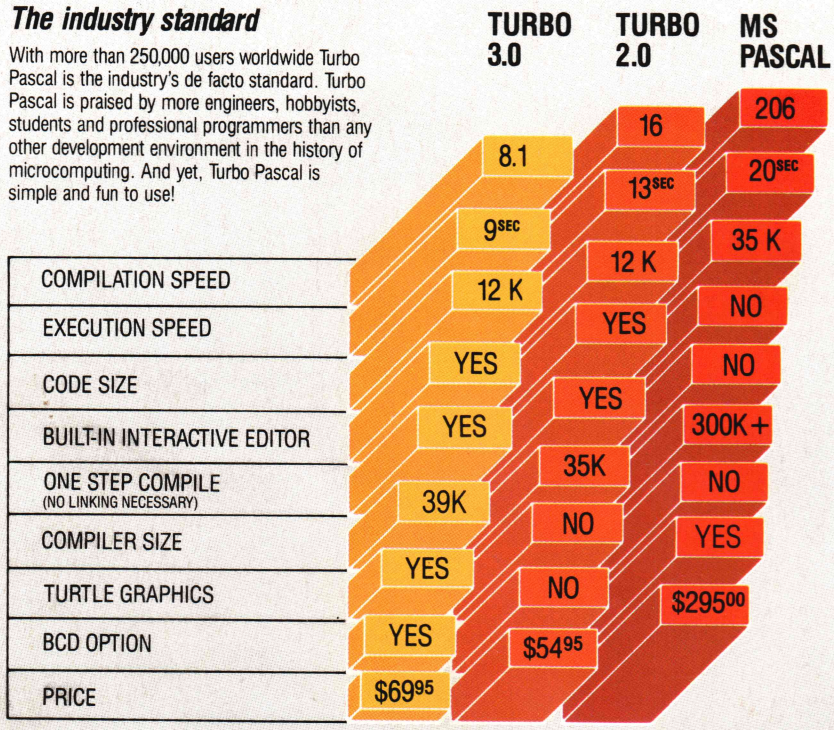

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(*) Benchmark run on an IBM PC using MS Pascal version 3.2 and the DOS linker version 2.6. The 179 line program used is the "Gauss-Seidel" program out of Alan R. Miller's book: *Pascal programs for scientists and engineers* (Sybex, page 128) with a 3 dimensional non-singular matrix and a relaxation coefficient of 1.0.

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